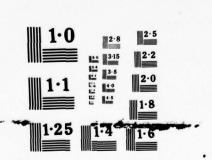
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SPECIFICATIONS FOR IDAMST SOFTWARE (MISSION ANALYSIS)

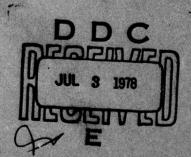
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Final Technical Report April 1976 - June 1976



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This final report was submitted by the Boeing Aerospace Company, Military Airplane Development, Seattle, Washington 98124, under contract F33615-76-C-1099, job order 2003 01 05, with the Air Force Avionics Laboratory, System Avionics Division. Mr. Lawrence L. Gutman/AFAL/AAA-1 was the project engineer. This report has been reviewed and cleared for open publication and/or public release by the Aeronautical Systems Division Office of Information (ASD/OIP) in accordance with AFR 190-17 and DODD 5230.9. There is no objection to unlimited distribution of this to the National Technical Information Service (NTIS). Publication of this report does not constitute Air Force approval of the reports findings or conclusions. It is published only for the exchange and stimulation of ideas.

Cavrence C. X

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Dwere developed into a specific IDAMST software design. The design is described in terms of functional, architectural, and configurational characteristics. The design documents consist of four Computer Program Development Specifications, Type B5 per MIL-STD-490 and MIL-STD-483. The IDAMST software design was based on DAIS architecture and adapted as required to meet the IDAMST requirements. The DAIS architecture proved to be flexible allowing the design to be extended to IDAMST without major change. The IDAMST system defined satisfies the functional and operational requirements of the AMST. The design consists of a dual redundant processor with a reprogrammable backup processor.



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FOREWORD

This report describes the results of a study performed for the Air Force Avionics Laboratory by the Boeing Aerospace Company, Military Airplane Development, under Contract F-33615-76-C-1099 of Project 2003.

The report describes the software documentation developed to define the IDAMST system for the AMST. The report details the approach used to define, design, and specify the ground and flight operational programs. The work was performed during April through June 1976, under the direction of Mr. David G. Tubb, Program Manager.

The author wishes to acknowledge the significant contribution to the program of Messrs. John Andrews, Al Crossgrove, Downey Cunningham, Harvey Kanemote, Paul Kappus, Joe Musgrave, Doug Smith, and Dr. Leroy Smith of The Boeing Company, Jim Gracia and William Hirt of Harris ESD, and Larry Gutman and Gary Wambold of the Air Force Avionics Laboratory.

This report was submitted by the author July 1976, has been reviewed, and is approved for publication.

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SECTION I INTRODUCTION

The data contained herein is the product of Mission Analysis Work performed in compliance with the Air Force Avionics Laboratory (AFAL) Work Statement included in Gontract No. F33615-76-C-1099. That contract supports the Phase I development of software specifications for the Integrated Digital Avionics for the Advanced Medium STOL Transport (IDAMST). Development of the specifications is an extension of a study performed by AFAL which defined the IDAMST conceptual design. The final report for that study was published by AFAL/AAA in March of 1975.

Under the AMST program the Air Force is funding the development of two aircraft designs by two contractors. The Boeing Company is responsible for production and initial testing of two prototype YC-14 aircraft while McDonnell-Douglas will perform the same tasks on the YC-15. A fly-off between the four aircraft will be exercised under Air Force direction to determine which of the two competitive models will become the basic design for C-130 replacement.

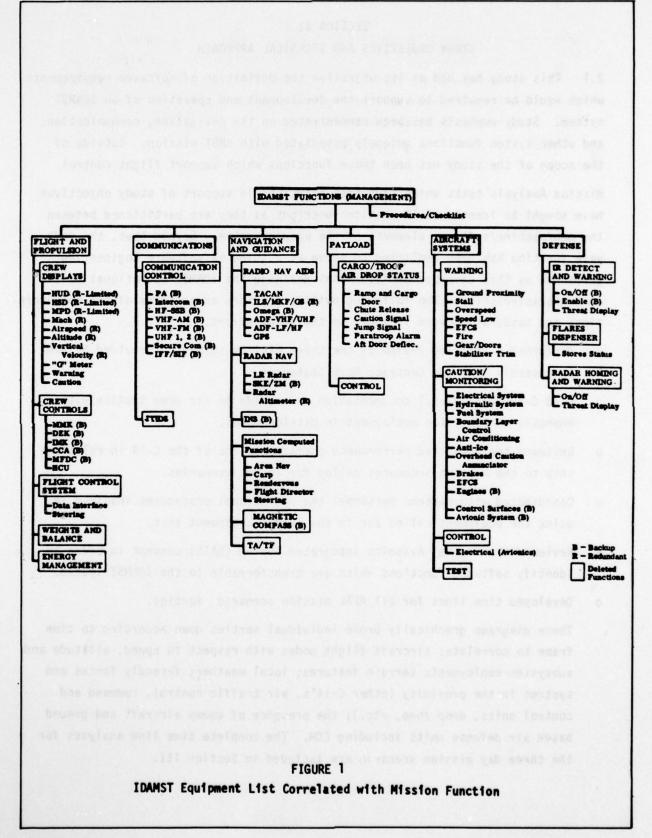
Since the prototype aircraft are primarily intended to demonstrate relative aircraft performance, their avionic suits employ fairly conventional components. But it is expected that the design selected as a result of the fly-off will be configured for production to incorporate advanced avionics equipment. The level of automation and integration of the components will in part be determined by studies directed toward assessing how well various crew sizes can handle the required functions involved in performing AMST missions. The IDAMST studies being conducted by AFAL are directed towards employing advanced concepts evolved from the DAIS program to develop a candidate design for the AMST aircraft operated by a two-man flight crew.

Both Boeing and McDonnell-Douglas have participated in the IDAMST study, each developing hardware and software configurations that could be potentially incorporated into their respective production designs. The following paragraphs in this section provide a brief introduction to the IDAMST C-14 and the missions to which it is addressed.

The C-14 will be a twin engine cargo aircraft which derives its STOL capability from the aerodynamic effects of upper surface blowing. Under the IDAMST concept, the avionics equipment will operate as an automated/integrated system. The

equipment list supporting required C-14 mission functions is shown on Figure 1. All flight and subsystem control will be exercised by a minimum sized crew. For this study, the flight crew was assumed to consist of a pilot and copilot. An additional crew member will be required to perform Load/Jump Master duties associated with cargo compartment management.

C-14 missions will include tactical deployment to distant theaters of operation; precision air drops of personnel and equipment from all altitudes down to practical minimums; Low Altitude Parachute Extraction (LAPE) of equipment; and STOL operations including rapid offload of equipment and/or personnel in forward combat areas. Most significantly, the aircraft must be capable of performing all of the functions included in the deployment and precision air drop elements under Instrument Meteorological Conditions (IMC). These then are the elements which form the basis of the IDAMST Mission Analysis study.



SECTION II STUDY OBJECTIVES AND TECHNICAL APPROACH

2.1 This study has had as its objective the definition of software requirements which would be required to support the development and operation of an IDAMST system. Study emphasis has been concentrated on the navigation, communication, and other system functions uniquely associated with AMST mission. Outside of the scope of the study has been those functions which support flight control.

Mission Analysis tasks which have been exercised in support of study objectives have sought to identify C-14 mission functions as they are partitioned between the man/machine/software elements of the weapon system. Beyond that, the software function has been amplified to serve as a guide to software Engineering personnel as they develop specifications defining the IDAMST operational software characteristics. The following outline provides an overview of the considerations and tasks which were included in the study effort.

- o Performed a detailed review of the three mission scenarios provided by AFAL in Appendix A of the Contract Work Statement.
- o Used C-130 operational documentation as a guide to air drop tactics with emphasis on subsystem employment in mission modes.
- o Reviewed the predicted performance characteristics of the C-14 in relationship to the mission sequences called for in the scenarios.
- Coordinated with systems personnel the operational procedures involved in using the equipment called for in the IDAMST equipment list.
- o Reviewed the Digital Avionics Integrated System (DAIS) concept in order to identify software functions which are transferrable to the IDAMST system.
- o Developed time lines for all AFAL mission scenario sorties.

These diagrams graphically broke individual sorties down according to time frame to correlate: aircraft flight modes with respect to speed, altitude and subsystem employment; terrain features; local weather; friendly forces and systems in the proximity (other C-14's, air traffic control, command and control units, drop zone, etc.); the presence of enemy aircraft and ground based air defense units including ECM. The complete time line analyses for the three day mission scenario are included in Section III.

o Developed composite mission scenario.

When the time line analysis was complete, it was obvious that each of the individual sorties flown during the three day scenario contained segments which imposed unique demands on the C-14 crew/system combination while other portions of the sorties contained task performance which typically is repeated throughout the three day mission. Figures 2 through 4 illustrate the situation with the heavy lines representing segments of interest. In order to focus the development of Subsystem Sequence Diagrams (SSD's) and Functional Sequence Diagrams (FSD's) on C-14 tasks where analysis of IDAMST was needed, these segments were integrated to form a composite mission. Figure 5 graphically summarizes the events included in that mission. The segments which are contained in the six circled regions have been designated subjects of second level FSD analysis, to be discussed shortly.

Developed Subsystem Sequence Diagrams (SSD's)

Events occurring in the composite scenario call for rapid execution of a large number of individual tasks which contribute to the successful performance of tactical functions associated with mission objectives. At any one time, tasks simultaneously being performed may include navigation, communication, IFF, SKE, ECM, etc. In varying degrees each task requires coordinated crew and subsystem operations interfaced through the use of dedicated software programs. When all of the individual programs required by the composite scenario are assembled, they then become the repertoire which enables the C-14 to selectively perform any of the functions included in the AMST Required Operating Capability during a given sortie. The individual programs included in the repertoire are system-function related, rather than scenario related. For each unique system function, there is a specific sequence of operations which can be illustrated using flow diagram techniques. These schematics are referred to as Subsystem Sequence Diagrams (SSD's). Figure 6 illustrates the role of SSD's in the IDAMST analysis, and also serves to introduce the subject of Functional Sequence Diagrams. The SSD's developed during this study are included in Section IV.

o Developed Functional Sequence Diagrams (FSD's)

As Figure 6 implies, FSD's are directly related to the mission scenario. In fact, they are the graphical single thread which link individual SSD's to tasks to be performed in the scenario.

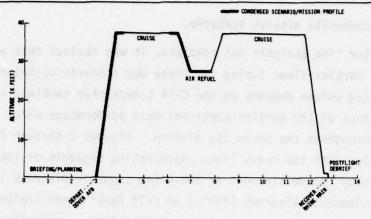


FIGURE 2: Flight Profile for First Day's Mission

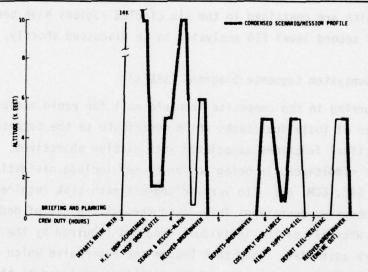


FIGURE 3: Flight Profiles for Second Day's Missions

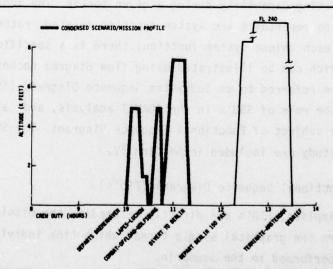


FIGURE 4: Flight Profiles for Third Day's Missions

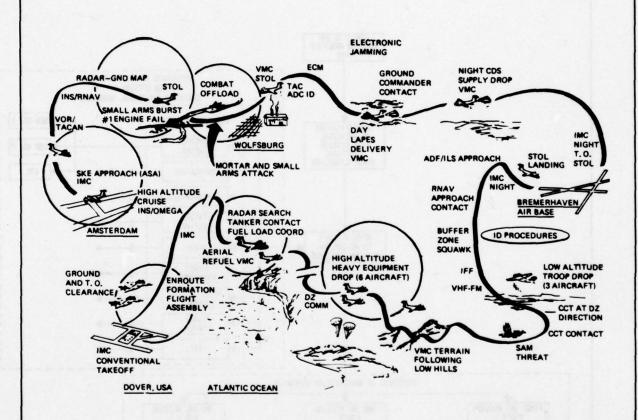


FIGURE 5: IDAMST Composite Mission Scenario

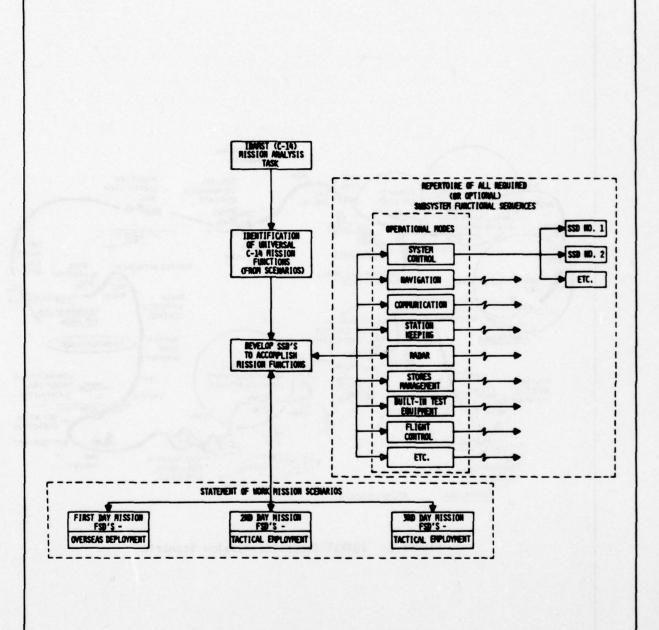


FIGURE 6: Interrelationship of IDAMST Mission Analysis Elements

As an analytical tool, FSD's are useful in several different ways. First they serve as a test to determine the availability and completeness of SSD's. Where deficiencies exist, the void can be identified as the subject of additional SSD development. Second, by correlating the simultaneous SSD functions called for by the FSD at a particular time in the scenario, it is possible for the analyst to scope man/machine task loading in gross terms.

Two FSD levels of indenture are included in this report.

The First Level has been used to facilitate the analysis of a complete single sortie selected from the various missions flown in the three day scenario. This FSD format provides insight as to the simultaneous activities of the three (pilot, copilot and loadmaster) man flight crew with indices to the detailed SSD operations that are required to respond to postulated scenario events. Section V contains all of the First Level FSD's and associated analysis generated during the study.

The Second Level FSD has been used as the basis for analysis applied to instances of high task loading occurring in the composite scenario. (Reference the six circled regions of Figure 5). This particular approach focuses attention on the interaction of the individual crewman with those software and hardware elements which best enable him to respond to scenario events. While the technique still relies on SSD references to provide ultimate detail, the Second Level FSD itself amplifies information on software/hardware functional requirements. Section VI includes the Second Level FSD's dealing with composite scenario events.

SECTION III TIME LINE ANALYSES

A detailed overview of the flight crew tasks and functions was obtained by describing on a rigid time base the actions necessary to establish the scenario flight profile. As can be seen in the following pages, each action is defined within the total context of the flight. Any interfering requirement is evident. Consequently, each action can be identified in relation to all other actions be they aircraft, flight crew, or ground related. This format quickly points out potential excessive workload problems.

As a result of the following analysis, potentially excessive workload areas were noted and were then analyzed further in the Level 2 FSD's of Section VI.

The time line analyses cover the three composite missions selected for detailed study and cover the following flight modes:

Mission I	TIME
Aerial Refueling (Formation)	0640 - 0712
High Altitude H.E. Airdrop	0312 - 0336
Low Altitude Airdrop	0336 - 0400
Mission II	
CDS Airdrop (Formation)	0548 - 0624
Airborne Radar Approach	0624 - 0638
Mission III	
LAPES Delivery	1000 - 1032
STOL & Combat Offload	1032 - 1048
Departure Engine Failure	1046 - 1052
VOR & ILS Approach	1052 - 1104

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FIGURE NO. 7 Mission I - Aerial Refueling

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FIGURE NO. 8 Mission I - Aerial Refueling

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FIGURE NO. 9 Mission I - Aerial Refueling

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FIGURE NO. 10 - Aerial Refueling Mission I

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FIGURE NO. 11 - Aerial Refueling Mission I

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INTERNAL		45		1.7 000

FIGURE NO. 12 - Aerial Refueling Mission I

1700FT + + + + + + + + + + + + + + + + + + +	95 90 35		Oct Affects Niz denex -			
DAY	5: /& :					
27,000 FT.	55;	OP LEVERS OFF AT FLESO. O VISUAL CONTROL MAINTHINED WITH BUE 546.	OCP REPORTS "IZ COLOUN. BO MILES," BO MILES," BO PREMATION UNITED TO WANTERS TO WANTERS TO WANTERS FURMATION WISHINGTON	OCP REPORTS ALT. TO THANGE. OCP ADVISES BUESEL TO DISCONTINUE SKE.		
24,000 FT (PT. 1134) 10,000 (PT. 1134) 10,000 (PT. 1134)	TIME 3 (2.652)	T SEE	WAVIBITION	Cerruncanon ¢ cerruncanon	PHYLOND	INTERWAL

FIGURE NO. 13 - Aerial Refueling Mission I

27,000 FT 17,000 FT 17,000 FT	.59 : 59 07:00 280		S O CP REPORTS CP REPORTS "I.2 C/CLOCK — "I.2 C/CLOCK SD MILES." #5 MILES." #5 MILES."			
27, 200 F.		COMMUNIC	,0 CP REPORTS 12 d'ULDEK - 12 d'ULDEK - 12 d'ULDEK -			
15,000 ALTRUDE (FT. MSL.) 10,000 5,000	THE E OB SPECO (KIRS) DISTANCE (KM) FLIGHT	PROPULSION CONTROL	NOTHERMAN	CONTUNICATION	ONO.	INTERNAL

FIGURE NO. 14 - Aerial Refueling Mission I

12 cap 12	10:	SION COMMUNAL	" SELIN OH - NOULD II.	O NEW F	The state of the s	
		om aue Sib.	19 .			
× 24	20:		0 CP REPORTS 17. 0 CLECK 35. MILES."	O new E	to s	
	:03		0 0 Pereds	⊕ new €		
14 080 + + +	40 00	1000			i i	

FIGURE NO. 15 - Aerial Refueling Mission I

FIGURE NO. 16 - Aerial Refueling Mission I

	21120 II: OT:		AS' THE REFUEL CONTINUES TO OTBO. SEE			
12,000 FT NATITUDE (FT. M34) 10,000- 5,000-	DISTANCE (MM)	PLIANT PROPULSION CONTROL	O CP ASTA	CONTUNERMON	GWOTAW	INTERWAL

FIGURE NO. 17 - Aerial Refueling Mission I

TRIST 13,000 FT.		O ANGEGRAT PROCEDURES CONCRED (PACP) 1. SCHOLDOWN & AS, 1. ORDP PRINT & ALT. 1. DEMPINE PROC. 1. DE HEADING	O DETERNINE 20MIN FROM CARP. (CP) ALEIT PLOTE ON. O REMECK PLAND OARP HEADING. AIR SPEED, TRACK, HEADING.		GSTART 20 MILL, MIRDROP CHEKS 4 PREMARATION OF PAYLOAD 5 MIRDROP HARDWARE CHEKED 6 UM ACKNOWAEDES	
	:13	O AIRCEAFT POC · CONTINUAL · SCHOOL · DEDP PON · DETRACK · DE TRACK · DE HENDIN	O DETENTALE 1 ALENT PILOT. O REWA IP ALL HEAD!	17.9	GUM ACKNE	

FIGURE NO. 18 Mission I - High Altitude Heavy Equipment Airdrop

Soi Smil Ind.	CONTINUAL (1) (1) (2) (3) (4) (5) (5) (6) (6) (7) (7) (7) (8) (9) (9) (9) (9) (9) (9) (9	O CONCENT / NSTRUCTIONS TO ELEMENT \$ 30 SEC. LOWE SHIP FOR NOWINGER WARNING O \$ SEC. WARNING RADAR O 5 SEC. WARNING RADAR O CONTROL MANCHER RADAR O CONTROL MANCHER RADAR O STATE INDEXING	O"10 MIN " CHEK COMPLETED	Swa- my 6
ATTRIDE (FT. MSC.) 10,000- STORD- STORD- STORD-	PRÉDICTION SIO	NAVIGETION CONTUNICATION CONTUNICATION CONTUNICATION	тисло	INTERWAL

FIGURE NO. 19 Mission I - High Altitude Heavy Equipment Airdrop

	WIS > 10 MR	123 52:	D PLEMT THAN TO CS 9	O DETECTINE O THEN PENT IO MIN, FROM SHEM, FROM CARP, NIN, SYSTEM,	ORGHT TURY ORIGHT TURY 30 SEC. WARN, CHEVITE O IONIM, WARNING	O STRET I DAW. AIRPROP CHEKS	
NEH	6 -62 62	-12; l2;	COMINUM	Therefore in the second	OLONE SHIP" MILTARY RADAR. ADVISORIES RE' EMENY & DUN AIRCRAFT	THE RESERVE	
Turns:	ALTITUDE 19000 (FT. MSL) 19,000	THE E 03 20		NOTERNAM	COMPUNICATION ¢ ¢ OEFENSE	тушар	INTERWAL

FIGURE NO. 20 Mission I - High Altitude Heavy Equipment Airdrop

THOIN	LIGHT BACK	जह रहा है।; जह है।; U:	O DESCONT PROMER DESCRIPTION OF RESOURCE PROMER O DESCRIPTION OF SUMME, PICE (7)		O DELENT 1 NSTRUCTONS POR SUPER POR TO ELENENT \$ 30 SEC. RADAR ADVISOR DELENTS DESCRIPE DELENTS DELENT	OTENNY " CHEK COMPLETED	SWOI-104
	ACTITION (OFT. MSA.) (OFT. MSA.)	THE E CENS 310	W. S. C. L.	MINGTON	CONTUNICATION	GA0UARD	

FIGURE NO. 19 Mission I - High Altitude Heavy Equipment Airdrup

N/GH	€ 9.000 FT. 5. > 10 mm,	राः राः	ALTIMETERS CHECED \$ PEST IL OF \$ STABLES SOO NTS.	O POSTION UPDATE BY GEST AVAILABLE FIX, O ENTER UP DATE IN NAU. COMPUTER.	AIRLEAFT CARES DEOP PERMISSION FRENT DE. (C) RAIDE SERVETS OLINE SHIP RAIDE REPORTS ON WATER CONTROL OF FLONT ELEMENT MANDED TO BACKLAFF FOR FURTHER ADMORPS	© UN REPORTS IOMIN CHECKS CONFESTED	WE COCKRIT CESSURIZED © MATH ICING & DE-ICING OFF
	(9) (8)	988	ONTINUAL ONTINUAL ONTINUAL ONTINUAL ONTINUAL ONTINUAL ONTINUAL ONTINUAL ONTINUAL		DIENTEL OFF SHOWER SENT TO ELEPHANT N D 30 SEL WARNING B 548	© un referens commercia com	O CABIN & COCKRIT DEPRESSIRIZED O ANTI-ICING & DE-ICING OFF
	ALTITUDE 13,000 (PT. M34) 10,000	THE TO (KINS)	FLENT PROPERTY CONTROL	NAVIBRITION	OLENER DE SECTION DE S	mywas	INTERWAL SKITEMS

FIGURE NO. 21 Mission I - High Altitude Heavy Equipment Airdrop

	.3] <u>15.</u>	0 0x m ev; (c) 0 0x m ev; (c)			O CARRO DEPES CORRED & CARROLLIM) LOCKED REPORT(M) WAS SUCURDAN CHECKE COMPLETED \$ RPTD. (M)	
•	35:	ED BRAKES UP UNG FLAPS — 2 PRIVATION CONTROL SYSTEM RESET O OK TO OPEN REAR CAREO DOORS (P)			© REGUESTS OC TO © CARBO OPEN PERR CAREO OPENE DOORS (LV) OSTART OPENING REAR CAREO DOORS (LA)	
(0,000 FT.	82: 02/	8 0 0	O SKE SECONDREY CONTROL PANEL RESET (CP)		9	
(FT, M3L) 10,000 5,000	TIME 2- 035-8 210	1 1 24	NAMESTION	COMPUNICATION	мусяв	INTERNAL

FIGURE NO. 22 Mission I - High Altitude Heavy Equipment Airdrop

ALTITUDE (PT. MSL.) 10,000		d de la company	8		t
KIMS	07/	:35 Oz/	.3∳		03 36 (20 ±
FLIGHT FROPULSION CONTROL	OOK LT RIT(E)	WE ELEMENT (SIC)(C) O KINTES (NOS)(C) OCH (SIC) (CH. T. R.	COCP TUBERS ON CLOSURE OCT TUBERS ON CLOSURE OCT TO RETO LIGHT. OCT TO RETO (EP)	OSTANT LEFT THEN TO 312'() OSTANT ALBERTHON TO 300 AT () OF APPS DETENCINED (A) OCY A RET (A)	
MUGHTON	D CARP DETREMINED (cf)	O AT CARP APTER E REPORTED (C) SENAL (C) GRENT (C)	O'RED LIGHT " POSITION DETERMINED (EP)	O MONITOR TIDEN TO AVOID BORDER	
COMPUNICATION CEFENSE	S ITHM. WARNING (CF)		OCP CNUS.	**BACRUMSH" RADAR (MP) ADVISORY - BVENY (MP) • RED LIGHT OFF (CP)	<u> </u>
my LOAD	O IMIN. WARNING NOTED. (UT) O IMM. CHECK GONPLETED (UT) \$ RATO	O'SEEN LEAT ON	O"RED LIGHT " ON RITE O"LOND 1S CLENE" O START CLOSUR OF DODE \$ PAY	O"RED LIGHT " ON RITICH O"RED LIGHT" OFF O"LOND IS CLENE" BILLY. O"THET CLOSUE O DORE & RIMP CLOSED & OF DORE & RAMP CONTENTS. OF DORE & RAMP CONTENTS.	4, LE
INTERWAL				O REPRESSURIZE AIRPLANE (CP)	

FIGURE NO. 23 Mission I - High Altitude Heavy Equipment Airdrop

6	300	DO KTS. IN IN IN IN INCE	Power Services (MS) (MS) (MS) (MS) (MS) (MS) (MS) (MS)	Ber. Ger.		
111	3	O GPUS O STRET THEN REMEDICED TO COSS. OPERATORIAL © LEVEL FIT & 320 KTS. OPERATORIAL © LEVEL (P.) INT. TERBANI CLEARANCE HOO TO 1320 FT.	O NEW LES WANTENTS SYSTEM (MS) SYSTEM OPERISION CALLENTS CAL	O BYTERNAL TERMINATED SEONRITY, O ECM, POBOLZ, STATION,		
TO many parts assured in the control of the control		である。 (で) (で) (で) (で)		O DEMET HANDVER RODAR COMM. (4)		
THEHT THE THE THE THE THE THE THE THE TH	98:	O Power Reduced O SPED Brances Lowered		(c)		
A WE STA		O CHANGE OF LEND TO BLUE S.(P) O HOLD 312" HEADING	O SKE "LEMBER" CHANGED	OUMME OF LEAD O COMPLETED DROP BLUE 4 TO BLUE 5. REPORT TO ALCE (CP)	O START SPEED UP 2DMIN. CHECKLST (LM)	
ALTIBOS 15,000 (PT. M34.) 10,000 5,000	SPEED (KIRS) 300	FLENT FROPULSIC CONTROL	NOUNDATION	COMPUNICATION \$ 0EFENSE	ONU.	INTERNAL

FIGURE NO. 24 Mission I - Low Altitude Airdrop

NIGHT OF THE PROPERTY OF THE P	SWALL ARMS FIRE, RADME CONTROLLED GIVE	Z4: 15:	O CAL POR SARD UP O CAL POR SARD UP DE ZOMIN, & IDMIN.	GIONNY FROM CARP DETERMINED G MONITORS RADAR (CP) 616MAL TO P.(Er) MAY, SYSTEM SIGNAL TO P.(Er) MAY, SYSTEM STORMINED	O IDMIN, WARNING DENEMY BUTLL NEWS FIRE NOTED	O IONIN, WARNING REMOVEL. (LM) SPRED UP OF ZDMIN, CHECKS & IOMIN. CHECKS & COMIN. CHECKS & OPPREDENTES ON THE STE	O CABIN DEPRESS, (CP)
ATTRUDE (SOOD) (PT. M34) 10,000	- cow's	98 98	FLENT PROPULSION CONTROL	NOTION NOTION	CONTINUESTON	D C C C C C C C C C C C C C C C C C C C	INTERNAL & C

FIGURE NO. 25 Mission I - Low Altitude Airdrop

ALTRUDE (PT. M3L) 10,000- S,000-	<u> </u>	
THE P 03	24:	:46 300
1 . 07	© HODING 352. © ALTINETERS RESET(CP) CONTINUAL	O START TUBN O WING FLAPS — 1/2(tr) TO 322*(P) OREDIZE POWER(P) OHOLD 322*(P) O COWNER SPEED BRAKES(P) O SLOWDOWN CHERKS STRETED (F)
Natheinen	DETERMINED (C) DETERMINED (C) OPERS RED LIGHT ON (C)	O TURN PRINT FIX CONFIRMED (W3/EP) (Redon, you account)
COMMUNICATION \$\frac{\darkappa}{\tau} \tau \tau \tau \tau \tau \tau \tau \tau	0	O ECM SHOUS RADHE DIRECTED SUNS \$ SAMS TRACKING (CP) HIPPLANE (CP) O PASSIVE EDM EQUIP (CM) COTHES PLOT — O SINNE POSITIONED TO
PRYLORD	O REDROP CHEUS CONFLETED O 671111. WARN, RELD. (1-1) O RED LIGHT ON	O AIR DEFICION DORS OPENED (C) O CLEARED TO COPEN PARATRODE DODES (CTD.) PARATRODE DODES (CTD.)
INTERMAL	O MIRAME DEPRESSURIZED O CABIN DEPRESS, CHECKED (CP)	

FIGURE NO. 26 Mission I - Low Altitude Airdrop

ALTITUDE ASSOCIATIONS (FT PSL)		₹		
2,000	/200T.	o care		
	03.48 12.0	ds:	.55/ 03522 120	2
DISTANCE (PD) FLIGHT & PROPUSION CONTROL	CONTINUAL.	O SREWY LIGHT ON (L)	O RED LIWIT BY (CR LIBRY OFF)	9
MVIGATION	O IP IDENT (C) O IMIN ENT NOTES PROJECT OF IP. (C)	O'SEEL DARWING (CP)		
COPPLETION & REFENSE	SECRET'S LIME SECRET (C.) O CONTRETS PORD 12, POSITION 4 EST DROP (C.) REMINENTS ECH MERST (C.)			
PAYLOND	O IMIN. WARNING O IMIN. CHECK COMPLETED (UT TO CA)	CA CARSEN LEAT	O'COAD CLEAR " (L-) O ALC GRACERE O START CLOSE & SECURE OF PARATURE DECOSO (L-) OF PARATURE DECOSO (L-) DECOSO (L-) DECOS (L-) DECOS (L-) DECOS (L-)	S & CHECK Danks S & CHECK (C)
INTERNAL SYSTEMS				

FIGURE NO. 27 Mission I - Low Altitude Airdrop

	35 55 0.35 0.35 0.35 0.35 0.35 0.35 0.35	START	RADAR FIX (?) " METHY" (C.) " UR JENY"	F B		
	03.52 :53 :625. :53	O'FLAPE UP'(P) O INCLEFASE ENGINE PRIER (P) O RAP HANDE O RAP HANDE O RAP HANDE O MANDE O MANDE O HOLD O HOLD	D POSITION AX \$ INS SYSTEM UPDATE	O ECM SIGNALS MONTRED (CP) O FEC (CP)		O START AIRPLANE REPRESSURIZING
ALTITUDE (FT PSL.) 10,000	Set (pus) 03		MVIGATION	COPPLINICATION A DEFENSE	PAYLOND	INTERNAL

FIGURE NO. 28 Mission I - Low Altitude Airdrop

Mission I - Low Altitude Airdrop FIGURE NO. 29

ALTITUDE (FT PSL) 10,000	* *		MIGHT			
æs						
DISTANCE (MIN)	320	10:	20:	:03	40.40	
FLIGHT & PROPULSION CONTROL		- CDTINUM.				
MAVIGATION						
COMPUNICATION & DEFENSE	O CP CONTROLS & THANKS PORO 12. PR 17845 THACE (UH = 2.) FRICE	ORNEN MAN ALLE DIRECTS BUNE 4 TO CONTACT RAMM MINN SAR ON 6750 (CA) (HE-358)	© CP LOWTHETS R M SHR LIWEN ADMISS F-16 PLOT ETECTED NORTH OF BEETRED HAVEN (HF-200)			
PAYLOND						
INTERNAL SYSTEMS						

FIGURE NO. 30 Mission II - Container Delivery System Airdrop

FLIGHT & PROPERTY OF STATE OF THE STATE OF T	STREET CLIMBURE DESTRUCT CLIMBURE DESTRUCT CAMBRIDE CEP ESTREET CAMBRIDE CEP ESTREET CAMBRIDE CEP ESTREET CAMBRIDE CEP ESTREET C		
PAYLOND		*	
LINEBRAL	Vision in the second se		

FIGURE NO. 31 Mission II - Container Delivery System Airdrop

15,000	(<i>ans</i>)	VFR		
000	\$000- BUE 4,566		5000 FT	_
20	97) 8th 50	05:		385
	OP NOMWCES PRIEK, OP REACES AUR. OP REACES AUR. OP HELDING FOR GREAT OF REACH OF LAND FOR OCHER TO CHECKLIST OCHECK OP ROTHITES FINES THE CHECKLIST ROCEL. NUMBRIES CLIMBOUT OCP-NFIRE TO CLIMB CHECKLIST ROCEL. ROCHIE (PLOS) OCP INTIMITES GONE UP, REPORTS UP,	G P HOLDING 3-3 40° MEAD. ST. CLUMB CHECKUST AP,	OLPGINES 30 SEC. WARN. LEVEL & ACCEL. SIGNAL ON SACE FCI. OP LEVELS OF	(2.)) ¥
	", 'OCP'' "	O CP MENTONS SKE DISEAN POR STA RETURNS. (TUS MORE)		
COPPLAICATION & DEFENSE	OCP RPTS SINET TD. TD BLUE ST/4 L, TUP.	OFFCF MWINGK OC AWE STE TO. DEP RPTS. STRETING OUN RPTS, STRETING LOMM, WRON CHECKLIST	OCP CONTROLS DEPTICIVE CONTROL (VIIP-AM) QCP SETS SQUADK \$\(\text{C}\) \(\text{C}\) \(\text{F}\) \(\text{F}\) \(\text{C}\) \(\text{F}\) \(\text{F}\) \(\text{C}\) \(\text{F}\) \(\text{F}\	gwe
8 8		OLM STRATS ZOMIN, WARN.	WARK.	
	OCP CHELKS OUP INDVITORS SYSTEMS SYSTEMS			

FIGURE NO. 32 Mission II - Container Delivery System Airdrop

15,000 ALTITUDE (FT PSL) 10,000	oo oo	TO WEEK	NIGHT VFR		
	25/20 200	:53	<i>15</i> :	25:	25.50
	DOWNWAL OF I	ACTUMES EMECUTE! (LATE CATALS OF SWET CLIMES, CALLS FOR PIWAL FOLLER CATALS FOR PIWAL CHECAUST. CP COPPLES		5	* ***********************************
MVIGATION	ACE PROVIDES ALLESTA PERMONS ACE PROFILE IND ROSHION.	OCP NOTES BLUE SYLES (SAE). COMMINES MANIDA	STS CONTRAIN.	*1	
OPPRICATION LIEFDISE	OCP MEDIESTS OCP CONTROLS A NALE STE . DEPARTO BLUE STE . DEPARTO	OCP CONTROLS BEFREENWEN ACE, HF-558, SINES ELEPENT DEPARTURE REPORT. CHECK COMPLETED.	V ENT	GCF CONTICTS HYDEURG RADAR, KPTS PESTOW (UR SEDVE VOXE), GVELE GVES BUFFER ZOWÉ EVTRY OK.	
PATON			92		
INTERNAL			officials		

FIGURE NO. 33 Mission II - Container Delivery System Airdrop

VINC		R STRIDE CHECKS CHECKS CHECKS CHECKS RED; RED; RED; RED; REDRING SWO, MAP REDRING SWO, MAP REDRING FEBRINST VISUAL	COMM. CHANNELS, CONTINUAL.	Stephen Stephe	
SOOF (18)	5 5 5 30 S	OCP NOTES I MIN, OUT PROM HAMBURS	GCP GINES 305E. DESCENT AND. ON SKE PCI.		

FIGURE NO. 34 Mission II - Container Delivery System Airdrop

ALTITUDE 15,000 (FT 1931) 10,000 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	10: 000 000 000 000 000 000 000 000 000	PHOPULSION CONTINUE CONT	MATCATION WISHING AND COMPANY OF WASTERN AND COMP WISH WASTERN AND COMP WISHING WISHIN	COPPURICATION OCE NOTS. FRET. OCE TO PELM. OCE NATS. EXECUTE SIGNAL VIA SKE	PAYLOND AMEN. CHECKLIST	INTERMAL Systems
8	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	The size of the party of the size of the s		OCP CAUS WEEK DE. NO REPOYSE.		
WAC.	20; 27,	OP REQUESTS 30 SEC. SCOUDOWN UNRANUE X-17. OP CALLS "SLOWDOWN EXCELL TE "		© CO ROBBITS CALL GOOD REPENTS CALL © COP REPONS WARNING SOFT TO ELEMENT, (SKE PL.)	類	
	03		CP GIVES Draw, WAR	ONLY NOT NOT THE COUNTY ONLY ONLY ONLY ONLY ONLY ONLY ONLY ON ONLY OF THE ONLY OF THE ONLY ON ONLY ONLY		
	1/500 / 1/20 / 1	TOWN FETED	CP GINESO	Sign :		

FIGURE NO. 35 Mission II - Container Delivery System Airdrop

ALTITUDE (FT PSL) 10,000	September Constitution of the Constitution of				
\$000	ISBOFT, MS		STATE OF THE PARTY		ZOOF US
	50: +0 90		90:	20:	801 90
DISTANCE (NA)	7	7	7		2 2
	ES. COMMES ON THE MAN SOLD EXTENDS ON THE MAN SOLD EXTENDS ON THE MAN SOLD ON	OF MOUSTS FRUER \$\frac{\psi}{5}\sinkts CESCONT \to 100FT \to Fig. \text{RAPS} TO _\hat{\to} \text{OP\$\$\frac{\psi}{6}\sinkty CESCONT \text{PAPS} TO _\hat{\to}	OF UNECIS CY TO WATCH FOR TWIESS ON ANDRE.	OP GIVES OK TO OPEN REAR COOKS & RAMP OS	OSPEED BONES RETRACT
MAVIGATION	OCP GIVES 67W OCP 6	OCP GIVE" BOENTE" SIGNAL VIA SITE OCP AGUSES AT PRE-IP.	TOTAL STATE OF THE	960	Constitution of the state of th
	DLM TO CP. OCO COMINUES AT	EMPTS			
COPPUNICATION 1. DEFENSE	OCP THONS RED LISAT ON \$ COULD RED LISAT	DE. NO RESPONSE. OCO TO PLUT			WITH HANDVER PREME
PAYLOAD	OLT" BMM, WRONING PROCEDURES COMPLETD" OLT RCKNDWX EDGES	8	OUT REAUESTS OK TO CPEN REAK CODES I RAMP. OL	1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	STS OUT REPORTS V ROWD & COOKED SE & COCKED O UN INTIRTES OFFWING REPORT DODES & FOWING.
SYSTEMS					

FIGURE NO. 36 Mission II - Container Delivery System Airdrop

15,000 (FT PSL) 10,000	0000 - 10000 K	Men T	השפטא	
\$000	16 00511000	ROFT, MSL	AGNO DIEGO	(000FT, 119.
WE TRIKE OF	80,90	60:	0/:	2190 //:
	CONTINUAL CONTINUAL	158	(a) OP DIRECTS NO DEDD " £ STRETS RESHT CLINEWS THEN TO LODD F: MSL.	O P PROCEEDS TO HOLD IN A RIGHT HIMO ROCE TRACK PATTERNO P OK" DODE, OFINES MENOR ROMP CLOSUR
MVIGATION	OCP IDEMINES IP	DOP GIVES "I MIN. WARNING."	OTEMSMITS (C)SIGNAL. VIA S OCY EVIES "SHEE TO CARP" RPT.	SKE PCI.
COPPLINICATION 8. DEFENSE	OCP CRUMS DE.		GCP REPARTS "NO COMPACT. "INTO COMPACT. "INTO GCP FROWINGS BLUE STEE OF NO DROP (WIR LIMP) OF SEPORT TO	OCP MOUSES DUBLE OF THAN MUNY FROM BORDER. S BLUE 5 & OCP CONTROLS P (VIR LIME) & REPORTS NO DE CONTROLS OCP REPORTS NO DE CONTROLS OF SAM TENCONS. POTIMITES EUR
PAYLOND	CHECKS COMPLETED	OUM IMM. WAN. PROEDURES PROPAUSAED \$ REPORTED.	The Control	Our resuests ac To close case & same Our winates case, ramp cusure,
INTERNAL				

FIGURE NO. 37 Mission II - Container Delivery System Airdrop

ALTITUDE (FT MSL) 10,000	× ×	JWI	
\$000	-00 -00 -00 -00 -00 -00 -00 -00 -00 -00	3 (4)	- supplies
	5/: ° '2/:90	<i>\$1</i> :	90 5/:
DISTANCE (NII)	3		3
FLIGHT & PROPULSION CONTROL	OHOLDING IN RT. HAND RALE TRACK PATTERN. CONTINUAL OCP TURNS RED LIGHT OFF		© P HODNS 24M. RT. HAND RRE TRACK.
MVIGATION			
COPPUNICATION & DEFENSE	OCP ADVISES ALLE OF NO COMM, WITH OE, REQUESTS ALTERNATE FREG. PATTERN & STAND BY.		DEREMENHAUEN RICE APPROVES WERCK AR DROP OCH RELAYS DROP CLEARANCE TO BLUE 5 \$6.\$UM. RECEIVES THEIR RUKNOULEDSMANT.
PAYLOAD			
INTERNAL			

FIGURE NO. 38 Mission II - Container Delivery System Airdrop

	LUCKCK, HOLDING.	NIGHT	
15,000 (FT PSL) 10,000	• •	VMC	
\$1000	- C		
11	21. 27.	<i>81:</i>	07.190
DISTANTE OPD FLIGHT & PROPULSION CONTROL	CONTINUM	SPOKTO CONTROLLING	2.5 OP REDUCES FRUER & EXTENUS SPEED BOOKES
MVIGATION	OCP GIVES GAIN. WARNING GCP TURNS RED LIENT ON \$ RPTS, RED LIENT		
COPPUNICATION & DEFENSE		OCP MOODWADEES UN RPT. O 30 SE	O SO SEC. SECUTORION O SO SEC. SECUTORION O EXECUTOR SECUTORION SENT ON FCE.
PAYLOND	OUT PLONOMEDIESS RED LIGHT.	OUN ROTS ENIM WHEN. CHECKS CONFERENCESTS OK TO CHECK ASTRONOMY DEPART CONFERENCESTS	OUT REPORTS TONGS & RAMP GROW & LOCKED.
INTERM			

FIGURE NO. 39 Mission II - Container Delivery System Airdrop

15,000 (FT PSL) 10,000- 5,000-					
TITUDE 10,000-			MC		+
\$000			WBECK		
			MRDROP		-+
		200 FT. (754	9		1
TIE 7 06:20		,Z	:22	:23	26:24
			(20	(30	(40)
DISTANCE (NM)	7	2	2	2	4 - 38 70 60
3.	CONTINUAL	© P CHEKS HUD	CORPORATES	DEPMIT THE	
		ASANST MAP (MPD)	@ P TURNS ON	OF SHATS ACCEL.	
-	ESCENDS		PERMIT SWITCH	OF SINKIS SANKE	-
	שבויישבו סד			& CUMB TO SOODET.	·
				OCP OK DORK FRAM CIDENEE	Selection
+		@ MAY, 3YS, GIVES	OCP NOTES	@ CP NOTES	
MAVIGATION		I MIN. WARN. SENAL O P CHECKS MAP CISPLAY REANST MUD "TOT" SYMBOL	53E. WANNE	DAD OF DR	
		OCP CALS IMM.	OCP CALLS	@ CP CP/U.S.	
COPPUNICATION		WARNING	See CALLS	"RED LIGHT"	
& DEFENSE			Sector Library	@ LM ACKNOWLEDGES	_
				RED LIGHT	
		OLM RPIS IMM. CHECKS COMPLETE	XS COMPLETE	CLOSORE OK.	
1000		OUT MERSES	OW REST TO	OLY INTIMES DODE	206
		CHUTE SAFETY	PULL MANUAL		1
PATLUAD		LINE & REMOVES	RELEASE. IF		: UNES,
		SAFETY SHEATH	NECESSARY. GATE RELBA	CLERR	3.
FOWAI					
SYSTEMS					

FIGURE NO. 40 Mission II - Container Delivery System Airdrop

ALTITUDE (FT MSL) 10,000		WC IMC	+ + +
\$000		Brooff, Ob.	MEL
STEP TRUES	25: 35: OM	72:	87. 90 200
a	COMMUNAL HOLDING TOWN STEED THE TOOK CLOSED SIG. ON LAN. OP CHEST TOWN ON 2005") "LOCAL TOWN ON 2005") "LOCAL TOWN ON 2005")	DOPTIONS OF CONSE OF PROCESS H TO FORE STREETS H TO FORE STREETS ENROUNT TO STREET MRUPHET THE STREET MOSE. OLP CHECKS OFF ENDOITE OFF TO USHIT I MOSE. TO COURSE SPEED.	
MVIGATION	O CP NOTES TURN UNIVENT ABENT LUBECK, INTRESS P.	O PFCP MONTOR SWE DISPLAY OF PARMYTON STRTUS (SKE TUS MOE)	
COPPLATION & DEFENSE	# OUT REPORTS DOOR # Now CLOSED LOOK OF " OCF REPORTS RED LIGHT OF " OCF REPORTS FROM DISCORPORT FROM DISCO	OCP INITIATES FILE F VOCE COMM. WITH BLUE STA. TO ESTRELISH 2 MI. SEMPHININ. ENES © KIEL W. REPORTS 27 MI. SE OCP FORWANDS GROP REPORT TO MICE.	
PAYLOND	OUM SEUNCES ONNES OFF, OFF, ROTS CARBO MART SEURE.		
UNTERNAL			

FIGURE NO. 41 Mission II - Airborne Radar Approach

15,000	*	IMC	+
ALTITURE (FT MSL) 10,000		⊕ 1900 H MS	\
16	32: 30	:30	06132
DISTANCE (NP)	4.7	PSELECTS ©	MIN.
FLIGHT & PROPULSION CONTROL	TO ISTURIES DESCRIBE OFFICE STRELLSH TO ISTOPIT. AND DESCRIBED ROPROPICH STANDON FOR PRICE & TRACK ARA REPROPICH.	LAND" MASTER DESIRED APPROPRY MODE ANGLE & DISTRACE OC P STARTS CHECKUST OUT TO START FOR MOS & LINDING. DESCENT. (MPD)	ACT. \$ missed APPROACH ROCEDURE OFFICEMED.
MAVIGATION	O NIEL RAWAR REFLECTORS OCO ENTERS UMB FOR AT APPROXY BUD COMPUTED "GLIDE SLOPE OF RUMUNY HOSCINED MID LOCALIZER", STERCINES ON GAD, RODGER, MAY SYSTEM UPOPITED.	OCP REMED DATA FOR ALL VERIFIED PRE COMPATIFIE DA (MPD)	8
COPPLATOR B DEFENSE	DOLUE 4 (CP) CLEARED TO CENCEND TO 1500 FT. SOUR 5\$4 TO PROCESO AT SOOD PT, \$\xi\$ HOLD OVER KIEL OCTOR REPORTS OCTOR REPO	m . 5	االج
PAYLOAD			
INTERNAL Systems			

FIGURE NO. 42 Mission II - Airborne Radar Approach

IMC IMC	1.55 EE:	CONTINUAL ACTION OF THE TOTAL	ON SUIS 40M. ON SUIS 40M. SOFT. LOW ON '65." OCP TOTS. "SWM INDO FT. ON SUISE SOFE "	OCP RETS "KY IN SECT - LANDING "	DUMDING LIGHTS THOUGH PARES FLAP HANGE TO FILL DEW FESTION, FONTINES, & FEDORTS FESTION.
	Se Se	TRUNCAM & MIRTANE & MIRTAN	NOMICES UND MEDELIST TO METER UNDE		men,

FIGURE NO. 43 Mission II - Airborne Radar Approach

		LUBBOX - KIEL				
15	ALTITUDE (FT PSL) 10,000					+
	\$000	. 1		BUVE STEE STRICT ASSA APPRECACY ON BLUE 4 LOCATION		
胖	Will print Oct	36 36	:37	:38	:34	9
		CONTINUAL POSTION NEAR, CONTINUAL POSTION NEAR, OFF OF END OF APPROACH RY, DESINE RUNNING PROMISE RUNNING PROM	VE RY. & FINDS A POSITION NEAR, BUT OFF OF, END OF APPROACH RY. ENGINE FORMING TO	FRY. & FINDS A POSTION NEAR, BUT OFF OF, END OF APPROAD RY, DUSINE RUNNING, PURP.		
8	MVIGATION	OF TRAILES & FINDS CESIRED POSTION FOR THE PORT INVOIT CHART CHART CHART CHART CHART (OR FLEET, MAP.)	ONCE COUT TT. MAP B)	DOP RATS AFER-LANDING CHENCUST COMPLETED —		
1 DE	COPULATION A DEFENSE	OCP RPTS. TRIXI TO BUSE SEE.	OCP REPORTS BLUE 4 PRINCED, SIVES OFFSET TO BLUE 5/46. BERINS PROVIDING ASA GUIDANCE.	BLUE 4 5 OFFSET 6. BEENS 7 GUIDANCE.		
PAYI	PAYLOAD			N S		
SYS	INTERNAL Systems					

FIGURE NO. 44 Mission II - Airborne Radar Approach

ALTITUDE (FT PSL) 10,000	. WC.	44
\$000	SUE 4 DALY	TJac.
O' (Strat) or all	100 200 (a) (a) (a)	100 CO:
	Sources OF Activities of Cours Fire Courseller (France) Sources Courseller (France)	Pouries SOF CHUS MERCIST POR COUNTY LONDRETTE CHROCOLS
MVIGATION	E HANDUR VOR E HANDUR VOR BENETING CHECKS - NO SHAMES, EP © ARER MAK SYSTEM FUNCTIONING	DE OND MAP EADORE E VISUAL PROTINGE KAN, CHECKS OF SHIPM,
COPPURICATION & DEFENSE	DOP NATE SINET OF TO RUN DESMINEE BOVIE RECEIVED ENEUER.	OCP RPTS AT ALTITUDE.
PAYLOND	OLM STATS CHEK ORTS MILLOND OF PINLOND. CHEK SELVER	
INTERNAL		

FIGURE NO. 45 Mission III - Low Altitude Parachute Extraction

15,000 (FT MSL) 10,000		VMC.	+ + +
	50. 100	20:	1008
DISTANCE (NO) FLIGHT & PROPULSION CONTROL	OP SINCE CRUISE CHEKLIST. OP THERS ON OUR OF SHEED (PECT) OF DIGHTERS PRUEE & SHEED (PECT) OF DIGHTERS "ENROTTE"	FOR FINISHES FORUME SETTING FORUME CHENCUST,	19
MAVIGATION	OPFCP USE USAM. FIXES TO URDATE MAY. 615.	OVISIAL PIX ON HYLRR.INTERSET. MAP REUMENCY INSUFF. FOR NAV UPDATE.	
COPPLINICATION & DEFENSE		OCF REPORTS POSITION TO EDED ALCE.	
18 12	See National Application of Section 1970 and 1970 ptg.	National Sections 1	

FIGURE NO. 46 Mission III - Low Altitude Parachute Extraction

15,000- (FT MSL) 10,000-		Day Imc	+ +
80 m (SIII) 1113		Ø:	:// Jail2
	20min, CARCALOTS		
MVIGATION	OCP NOWES LOCATION TO LOCATION TO LOCATION TO LINES PRINTS 20 MIN		OCP IDENTIFES BUSINE VISUALLY, CHECKS GND MAP RODAR BY RADAR FIX. MAY COMPUTER UPDATED.
COFFUNICATION & DEFENSE	Ounger Kindwieder	OCP RMS 20mm. UNEXCUST COMRETE OF ACCIDINEDSES	
PATLOND	O LM. STRATS		
INTERNAL			

FIGURE NO. 47 Mission III - Low Altitude Parachute Extraction

UMC.	113 S S S S S S S S S S S S S S S S S S			
	S. O. P. ALTERS 74 COURSE TO LUCHOW	OCP DETERMINES ROSITION OVER LIWEBURS, RDNISES P&LM.		

FIGURE NO. 48 Mission III - Low Altitude parachute Extraction

DAY	31: 5: 5: 5: 5: 5: 5: 5: 5: 5: 5: 5: 5: 5:	9.00 Froi		
	SO PROJESTS 10 PROJESTS 10 PROVIDED SO \$ STRETS CHEKLIST	OCF MONES IONN TO UNES REPORT	O UN ACOMUNETEES \$ STRETS UNDERLUST	

FIGURE NO. 49 Mission III - Low Altitude Parachute Extraction

15,000- MATITUDE (FT MSL) 10,000-		SWI SWI		+ +
Som Spec F	<i>b</i>			
ages.	081	1500 FUMM, 4		1570 FT.
07 07 10	72:	127	:23	42.01
DISTANCE (NY) 24	*	th +0/		
FLIGHT & PROPULSION CONTROL	O REDICES PRUBE \$ STRATS DESCENT TO 1500 FT, MSL. (P)	6	O CP RUNS SMIN CHERCIST	OP REDUCES PRUPE & RPTS SUNDOWN TO LE L'II REQUEST RECKLIST CHECKLIST
MVIGATION	OCP DETERMINES PRETION AT PRE-IP CADVISES PEUT. OCP UPDATES INS WITH PARTES FIX DATA	O P NOTES & MIN. COL REMOVED & MIN. SES CP & UM,	9	OCP MANIBORING NAMES & CALLS IP &
COMMUNICATION & DEFENSE	OCP POVISES BROWNSH'S REQUESTS PROVISION ANY BOOMES. OCP. (VIE.)	POCUMBH" E REQUESTS ON MAY OCP CALLS LIXMOND DE (VHF-FM) & RECEIVES OX FOR 'DEDP, SURFINE	1 3,	
PAYLOND LOWING CHECKLIST COMPLETED	6		The same of the sa	
INTERNAL		8	OCP CHECKS PACT OF HIGHWAY DEPOSTORIZED	Dia di

FIGURE NO. 50 Mission III - Low Altitude Parachute Extraction

UMC	25. (25) (25) (25)	Compared took Detach Visional Constitution of Parameters Compared took operate of the State of t	OCP REVIEWS TREENING HESS HERBATT & DR. BLEV. HERBATT & DR. BLEV. HERBATT & DR. BLEV. LOWFIRMS WITH P. CONFIRMS WITH P.	Dep ox " un RPT.	Our clemes to Defluis Our checks See Our che	
15,000+ (FT MSL) 10,000- \$000-	West (1018) 40 250		MAYIGATION	COMMUNICATION A DEFENSE	PAYLOND	INTERNAL

FIGURE NO. 51 Mission III - Low Altitude Parachute Extraction

15,000 (FT MSL) 10,000 \$,000 \$,000
FLIGHT & PROPULSION CONTROL
MAVIGATION
COMPLATION & DEFENSE
PAYLOAD
INTERNAL Systems

FIGURE NO. 52 Mission III - Low Altitude Parachute Extraction

	9					
	35: 28:	DP DP MALE SHOTS REMAND DESCRIT TO 1000/174. OP REDUCE FOURE. OP CALLS FORE DESCRIT UNCHAST	CO CP USING" PLETINGE" CROBENHET OF MAY © CP 10477115 LOTTINGEN ON OND MAP RADIR & WOUNTY	OP ADVISES "BACRUMSH" OF CHANGES HANDUR REDAK OF CHANGES		
Jun NOO		3	PELSHES TE & DEST THE WAY DEST. COND.		-33	
	33	O - P STARTS TURN TO SOUTH WAY NO HEND, COMMAND,	NEW PORTS			
	250	CONTINUE	OCP Visuri IDENT OVER			
15,000 (FT INSL.) 19,000	or Ishah Hisk	FLIGHT & PROPULSION CONTROL	MVIGATION	COPPURICATION & DEFENSE	PAYLOND	INTERNAL

FIGURE NO. 53 Mission III - STOL & Combat Off-Load

4	:39 10:40 (20 (20) 24.00.75 (200. MINSTER) MINSTER	© CP VISUM. NEDG. OF WOLEBURG			
AND TWO	12.50 :37 :38 :38 :38 :38 :38 :38 :38 :38 :38 :38	OPECP CONSTANT VISUAL CROSSCHECK OF PORTION F RNAV MOUNKS MAP	© CP CONTROTS LZ SITE COMPINDER (VHF-FM)		
15,000 ALTITUDE (FT MSL) 10,000	PED (KIAS) (20) DISTANCE (NIO) FLIGHT & PROPULSION CONTROL	MAVIGATION	. COMMUNICATION	PAYLOAD	INTERNAL SYSTEMS

FIGURE NO. 54 Mission III - STOL & Combat Off-Load

ALTITUDE (FT MSL) 10,000-	* * *		1		+
ALTO (SAS)	95 or 02/	<i>1</i> 4:		:43	200
	D STREET ONE DISCUSSION OF STREET OF	OP DECIDES ON MA STOL LAWONG. CALLS FIRE CHECKLET. CHECKLET. CHECKLET. CHECKLET.	ON MAKE EFFECT OF P. SERIE DELIN " NAS. NALS IP. TOPECTUST. OF CO.	DE DOWN RPROACH OF CHECAUSTER	F-16
MAVIGATION	SHEEM WEESENES, ONT IDENTIFIED.				
COPPLINICATION & DEFENSE		OCP CONTROTS About SITE CONTROL LANDING STRIP IDENT LES CONTROL CHINNEYS PUBBLINES BODGE VOSTICLES HOOFT, PROT IDVADOUN A	3	OTED + NO TURNASOUND, CARRIEL.	
PAYLOND		Sour Conders	15 S		
INTERNAL					

FIGURE NO. 55 Mission III - STOL & Combat Off-Load

*	10,000 EXCESSIVE WORKLOND TOKED TOKE	+ +
O) (SMS)	00t 9h: 0 5h: 0 miles	100 HB
FLIGHT & PROPULSION CONTROL	OF DEETS IMMEDIATE OF DESTREY OF DESTREY OF THE TO. OF	TOR OPERATOR. CHECKLIST & STAIDS ON TIRE & FUEL OP CALLS FIRED OP CALLS FLAPS. UPON MINIO CHECKLISTS. OP CALLS FLAPS UP. OCP PRTS, SCHREFLAPS UP. OP VERFIEDS *! ENSINE FRIUNG BY ENSINE DISPLAYS. * * MIT BY BURST OF SYALL ARMS FIRE.
NAVIGATION	And permitter Hightham SELECTS Long Line of Green of There-OFF MASTER MUSE PANEL.	POUL, CONTRE ENTINE TO: OCH PULS HANDE & REPORTS OCHOLIS "FUL FIRE HANDE V": OCH CONFUESE REPORTS HANDON THE LIGHT OCH CONFUESE WITH FIRE & FIEL WINN
COPPUNICATION & DEFENSE	MONISES, NEEA WOER LOAD CLEAR OF CONTROL ARMS LA CONTROL ARMS TO CLOSE RAMP FORMS TO CLOSE RAMP FORMS LA CONTROL ARMS LA CONTR	OP CALLS FUEL JETTEON TO YOU'SE SERVICE & MONITORS FUEL GLAWITH.
PAYLOAD	OLM OPENS CARSO DOOR OLM OPENS LOWER CARSO \$\frac{1}{4}\text{RAMP} \text{RAMP} \	ENGINE PUR. TO HELD GOODS. OUN RATS COOKS CLOSED & LOCKED NO POWOWLEDGEMENT, WAT'S FOR OUPSTION OR LESS IC ACTIVITY. OUT STARTS PRYLOAD RICHARD.
INTERNAL	PUGHT DECK OFFICIAL PIENT ON LIGHT ON PUGHT DECK OMSTEK FIZE LIGHT ON OMSTEK FIZE LI	SUNG UGHT ON SUNGE LOW LIGHT ON WAY

FIGURE NO. 56 Mission III - Departure & Engine Failure

15,000 ALTITUDE (FT MSL) 10,000	6 6	7m7		
\$000	o-			
No.	2007 2007	057 057	057 07 05:	10:52
FLIGHT & PROPULSION CONTROL	OP ORLES PER ENGINE PRILURE CHECKLIST COPOURIST OF REPRESENCE ON COO ENGINE TO ACCEL. COPOURIST OF REPRESENCE OF ENGINE PRILIBANTON CHECKLIST. FOR REVIEWS AFTER T.O. CHECKLIST TO COPOURISES UPPORTED FUEL TETTISCH FOUR CHECKLISTS COPOURISES UPPORTED FUEL TETTISCH FOUR CHECKLISTS COPOURISES ARE & FUEL WARN, CHECKLISTS COPOURISES ARE & FUEL WARN, CHECKLIST	COOD ENSINE TO MOCEL. TO CHECKUST TO NO. MENS COVERED COMPLETED.	OP INCREMENTS POWER & CALLS FOR SINGED SPEED SPEED SPEED OF ENGINE OF ENGINE CHIPS OF MINITERIES OF IMPURED. SPEED, SPEED	CALLS FOR SETTING & WE COMP ON SER. CLIMB
MAYIGATION	O PECP HALDING FIXED HERDING TENTRARIUS. DISTRAY FOR STRINGS.	PREMILY. DE CHECKS MAP BY VISUAL MEMS EVEREY POR DISPLAY DISPLAY FOR FORTION REPORTED ON MAP DISPLAY STATUS. SND MAP RADAR. SYSTEM IS INDER DUE TO LOW FOURER SUPPLY.	BOTH PLOTS CHELK POSITION BY VISUAL MEMS EVEREY POSITION KEPOKTED ON MAP DISPLAY. MATS TO OPERATE RADAR. SYSTEM NIE TO LOW POWER SUPPLY.	
COPPLINICATION S. DEFENSE	OLM RAT IC OCP ROUS,LM IC OCP COMMETS "SACKUMSH" REPORTS EMERSEWCY & CONDITIONS.	<u>, w</u>	© CP CONNECTS "ENCLANSA" REPORTS PLANS. "BRENEWAY REPORTS PLANS. BRENEYAND ALCE ROSTS.CLEARANCE. BRENEYAND ALCE ROSTS.CLEARANCE. BRISTER A TO DIVENT TO PROPERTY. AT STOOD FT. STOOM I SELECT	PLWS. ROSTS.CLEARMCE. F. TO SCOOT & SELM OFF.
PAYLOND	OUT NEWETS BY LAND MRCA SERVE & DORES CLOSED & LOCKED.	9		
INTERNAL SYSTEMS				

FIGURE NO. 57 Mission III - Departure & Engine Failure

200	3	28×	1985 Sacri,
ALTITUDE (FT ISL) 10,000	2 0		IMC.
\$000		SEED FT. MIST.	100000000000000000000000000000000000000
, Charles	.53 .550	<i>\tag{\text{*S}:</i>	35:
FLIGHT & PROPULSION CONTROL	O P CALLS FOR	O P CALLS FOR OPPINIUM S.E. SPEED & PUR, UAL OCF READS MPD TIBLE & HOTUSTS PUR.	© P NOTES FORMATION PRESIME,
MAVIGATION	0.CP 7	OCP MAKES EXACT VISUAL FIX & UPDATES NAV. SYSTEM OCP WINCE ANSTERDAM MAY. SYS. UPPATES MAY. SYS. UPPAMTS. OCP TUNES & IDENTIFIES NEUWKOOP VOR WIR IMK, MPD, & IC., DESIRED RADIAL ENTERED.	TRRED.
COMPLUTICATION & DEFENSE	REPORTING APPROPRIATE CITE. OLG REPORTING APPROVING STODDIT. THE CHARLES WE ARE WELL TO APPROVING TO STODDIT. STODDIT. STODDIT. STODDIT. STODDIT. STODDIT.	0 CP UNMESS IFF TO 3-40. OBREMBEHAVEN CIR. ADVISES IMMEDIATE CUMB TO 75DD FT. BECAUSE OF NO LONIDACT WITH FORMATION CROSSINS AT 5DDD FT.	OCP RATS AT 7500FT. EMTERING LITE.
PAYLOAD			
INTERNAL			

FIGURE NO. 58 Mission III - VOR & ILS Approach

TOPO 25,000 FT. DAY IM. CONDITIONAL UNIONS	10 II :03	OCF LIABLE LANDS OCF LAND APPEACH LONDS & RAMMEN. B CALLS FOR LANDING RAPS. O P CALLS FOR LANDING RAPS. O PROPERTY. O PROPERTY. O STANDS ST.		OUP ARRIVER THEN-OFF LED TO FINAL CLEROWING MET, TO CHANGE TO GUD, CONT. MIROWING TO CHANGE TO GUD, CONT. MIROWING TO CHANGE TO CHANGE TO GUD, CONT. CHAND. BIVES LARGET		
_\ \	10: 00/11	מיחייני	DUCKES BENNS OF POWERS. BUCH AREA MAP DISP. ADVITORED.	O CP RETA INCOMD. TRUER, LA WX & WMD.	20 PAR 2015	
15,000 (FT MSL) 10,000	SPEED (KLAS)	DISTANCE (ME) FLIGHT & PNOPULSION CONTROL	MVIGATION	COMMUNICATION A. DEFENSE	PAYLOND	INTERNAL

FIGURE NO. 59 Mission III - VOR & ILS Approach

ALTITUDE (FT MSL) 10,000		NEWARDP VOR		+
	95	358	:57	0011
	Spans pacent o single control Commun.	DE PROPESS OF INTIMITES ILLS COME CONSTITUTES INST. OF ACUMES "LAND" MASTER MODE		
MAVIGATION	•	OCP SETS & CHECKS ILS GENTLE & 2 MANUELL LOMPASS LOCATORS,		
COPPUNICATION & DEFENSE	OCP-MARKENTENTER CLEARS TO CROSS VOK BELOW GOD MANTRIAN 2000'TO OMIC.	OCP RATE VOR. ONTO THE WORL OFF TO CALLE ANTICECOM APPROVED TO CANTELLIAM APPROVED TO CANTELLIAM TO CAT. TO CAT.	OCP INFRAMS LA PREPAGE FOR LANDING.	
PAYLOAD	5 22 0 8 424 6 8 424 7 8 424 7	© UN RETS PAILUAD AREA BEDURE FOR UNDING.	3 0000	
INTERNAL				-

FIGURE NO. 60 Mission III - VOR & ILS Approach

SECTION IV SUBSYSTEM SEQUENCE DIAGRAMS (SSD'S)

4.1 OVERVIEW

Prior to the start of SSD development, significant segments of the composite mission were indexed to the time lines included in Section III. This review was exercised to identify independent system functional requirements which need to exist as a ready resource for call in the performance of any mission. SSD's for each requirement were then developed to incorporate system characteristics and operational concepts consistent with those postulated for C-14 employment. When it appeared that the SSD repertoire was reasonably complete, Functional Sequence Diagramming techniques were used to test the extent to which the existing SSD group met scenario requirements. Table 1 summarizes those SSD's which have been completed. It also identifies a group of SSD's which are required but, due to time constraints, were not developed during the current study.

TABLE 1
SUBSYSTEM SEQUENCE DIAGRAMS (SSD'S) IDENTIFIED DURING THE IDAMST STUDY

FIGURE	NO.	SHEET NO.	TITLE
61		1	GEN DATA INPUT/ERROR CORRECTION
62		1	TRANSFER DATA FROM ONE MPD TO SECOND MPD
64		1	COMM. SYS ICS/PA INITIALIZATION AND USE
65		1	COMM. SYS. CHANNEL SECTION - PRE PROGRAMMED
66		2	COMM. SYS. CHANNEL SECTION - PRE PROGRAMMED
67		1	ENERGIZE AND INIT. NAV. SYS.
68		2	ENERGIZE AND INIT. NAV. SYS.
69		3	ENERGIZE AND INIT. NAV. SYS.
70		neo l o tupa r	EXEC. OF FLT PLAN (AUTO OR MAN) WITH RADAR FIX FOR CARP CALC.
71		1	EXEC. OF FLT PLAN (AUTO OR MAN) WITH MAN FIX
72		1	EXEC. OF FLT PLAN (AUTO OR MAN) WITH PROVISION FOR REPLANNING
73		il 1 nges fil	STANDARD INSTRUMENT DEPARTURE (SID)/STANDARD TERMINAL AREA REQUIREMENT (STAR)
74		1	COURSE OFF-SET (BASED ON ESTABLISHED FLIGHT PLA

TABLE 1 (CONTINUED)

FIGURE NO.	SHEET NO.	TITLE
75	1	HOLDING PATTERN - CREW CONFIGURED
76	1	HOLDING PATTERN - CIRCULAR ABOUT AN INPUT POINT
77	1	HOLDING PATTERN - EXECUTION
78	1	SKE INITIALIZATION - PRIMARY CONTROL INPUTS
79	2	SKE INITIALIZATION - PRIMARY AND SECONDARY CONTROL INPUTS
80	3	SKE INITIALIZATION - DISPLAY INPUTS
81	4	SKE INITIALIZATION - DISPLAY INPUTS
82	5	SKE INITIALIZATION - DISPLAY INPUTS
83	1	SKE OPERATION
84	1	SET UP AND EXECUTE EQUIPMENT AIR DROPS
85	volume 1	AUTOMATED CHECKLISTS (INFLIGHT REFUELING)
86	1	EXPENDABLES INVENTORY AND MANAGEMENT - INITIALIZATION
87	1	EXPENDABLES INVENTORY AND MANAGEMENT - OPER. UPDATE
TOTAL TEMPE	TBD*	IDENT. FRIEND OR FOE (IFF)
	TBD	DEFENSIVE SYSTEM
-	TBD	TEST SUBSYSTEM
-	TBD	RADAR CONTROL SUBSYSTEM
-	TBD	FLIGHT CONTROL SUBSYSTEM
	TBD	MISC. AIRCRAFT SYSTEMS
STATIONACE:	TBD	GROUND PROXIMITY WARNING SYSTEM (GWPS)
O WELLS CONTRACTOR	TBD	SPECIAL PURPOSE ALERTS
-	TBD	AUTOMATIC DIRECTION FINDER (ADF) SUBSYSTEM
-	TBD	OPTIONAL DISPLAY MODES

^{*} TO BE DETERMINED - Identified as an SSD requirement during the IDAMST study, but left incomplete due to time limitations.

4.2 SSD FORMAT ELEMENTS

The formats developed for Figures 61 through 87 emphasize the role of "Computer Functions" in coordinating "Cockpit Functions" with "Subsystem Functions". The area reserved for computer functions appropriately is expanded to provide information of sufficient detail to support the preparation of an IDAMST software speci-

fication. Each SSD function involves data input from a specific source, computer processing of the data, and finally output to a predetermined destination. The objective of the SSD then is to provide information on the types of messages that can be expected to be transmitted through the system, and the levels of software programs that are needed to handle them. Programming levels of indenture then span Executive Control including prioritization through applications programs incorporating all of the applications subroutines. SSD's identify software functions that are needed for functional control, but they do not distinguish between Executive and applications programs. Software engineering personnel have the responsibility for that partitioning during their analysis of SSD functions.

It will be noted that decision-logic notation is frequently used throughout the SSD's. This device allows the analyst to provide information to software personnel as to system and crew actions that are elected based on assessments of conditional situations.

It is also noted that because of the purpose that the SSD is being used for (to provide software personnel with a functional overview), the SSD format allows for feedback loops as opposed to the strict time base suggested by AFAL. This allows a more concise representation to the process displayed by the SSD.

Under "Cockpit Functions" there are three sub-categories:

"Crew"- Based on symbology, this column provides information on how the operator senses and acts on cockpit internal/external and system generated cues. It will be noted that no attempt is made to designate whether the crew member is the pilot or copilot. SSD's presume that either one of them have the equipment, and could have the responsibility, to perform the required tasks.

<u>"Controls"</u> - This column is used to designate which dedicated or multipurpose controls are used by the operator to accomplish a particular task. It is also employed to show the required sequence of operations.

"Displays" - Depending on the nature of the Function being performed, either the operator or software may select one of the multipurpose or dedicated displays for data presentation. That selection is shown in this column.

"Subsystem Functions" provide three separate sub-columns ("SYSTEMS 1, 2 OR 3"). These areas are used to illustrate how hardware systems, whose operations com-

plement one another, are interfaced under computer control. It is recognized that systems such as the navigation system usually have their own processors and dedicated software. But for the SSD analysis all software functions are shown under "Computer Functions" rather than under the "SYSTEMS 1, 2 OR 3" columns.

The "External" column is used to show how cues originating outside of the subject C-14 effect that aircraft's system and crew functions. The cues may range from through-the-windshield visual observations to subsystem receipt of Electromagnetic radiation signals from external communication, navigation and radar systems.

The last column, "Time, Priority, Remarks", is used by the analyst to amplify the illustrated SSD flow. Wherever possible the comments have been noted adjacent to the flow segment to which they are addressed.

Table 2 provides the reader with symbology definitions used in the SSD's.

4.3 SUBSYSTEM SEQUENCE DIAGRAMS - ANALYSIS

Most of the analysis which has been performed during the study is summarized on the individual SSD sheets. The following paragraphs then will provide the reader with an introduction to each SSD subject as well as amplify points which were not noted on the diagrams.

Figure 61: General Data Input Including Error Correction

Since any set of operator generated inputs to the Integrated Multifunction Keyset (IMK) can be interrupted by errored punches, this SSD illustrates a generalized system logic for correcting those inputs. Implicit in the sequence is the requirement for automatic positioning of a cursor on the Multipurpose Display with which the operator is interacting. Through software the display control group must provide means of repositioning the cursor forward or reverse to locations of operator selection.

Figure 62: Transfer Data from One MPD to a Second MPD

The Function provided by this SSD recognizes the requirement for reconfiguration after a display system failure. Figure 63 illustrates display transfers growing out of a failure in MPD #1. This must be accomplished rapidly with minimum mission task interference, and with little or no loss of mission critical data. In certain instances where a data loss is inevitable due to insufficient remaining display capability, the software/hardware suit needs

TABLE 2 FSD/SSD Symbology

d 1000 TRAIN JOYCES OF TOOLS	a Bultimornia hadron a Reports set make
THE FOLLOWING SYMBOLS	ARE USED IN DEVELOPING FSD'S AND SSD'S:
SYMBOL	<u>MEANING</u>
O	RECEIVE
0	ACT
gatust seed of	MONITOR
	TRANSMIT
∇	STORE DATA
∇	RECALL DATA FROM STORAGE.
\Diamond	DECISION LOGIC
	(FOR EXAMPLE) MEANS THAT THE
AMPLIFYING 1	INFORMATION USED WITH SYMBOLS:
LEGEND	MEANING
A	AURAL
Berlin and E and an	ELECTRONIC/ELECTRICAL
SMIT DEPARTMENT OF M PAGE ME	MECHANICAL
RF	RADIO FREQUENCY
S	SPEECH
T	TOUCH
Windowski Wangari	VISUAL

to be flexible enough to provide for automatic prioritization with manual override available.

Figure 64: Communication System - ICS/PA Initialization and Use

When the aircraft electrical distribution system receives power from ground or internal generators, and when the computer has been initialized, the System Power Logic program enables the Intercommunications System/Public Address (ICS/PA) system to be energized. Subsequent to that, all control and use of ICS/PA equipment is independent of the computer facility.

Figures 65, 66: Communication System Channel Selection - Preprogrammed

This flow illustrates how the operator uses the IMK to assign frequencies for each radio to channel numbers in the computer. When those tuning choices have been made, displayed, and accepted ("ENTERED") - the tuning subroutine tunes each radio accordingly. If transmitter use is desired, the operator designates the set via the IMK channel keys and the computer implicitly enables the equipment as a function of the stored receiver tuning data.

Figures 67, 68, 69: Energize and Initialize Navigation System General Note:

The IDAMST navigation system is based on Area Navigation (R-NAV) concepts. Consequently the SSD's dealing with system initialization, use, and special operational features will reference R-NAV nomenclature.

Figure 67 shows software interface management of INS hardware initialization and alignment under operator control. Simultaneous with alignment, the flow reflects operator interaction with software via the IMK in setting flight plan operational parameters. These include waypoints with their respective commanded flight levels and system computed Estimated Time-Overheads (ETOH's) based on input estimated departure times. Subsequent to that the system is set in "NAV MODE" to initiate operational functioning.

Figure 70: Execution of Flight Plan (Automatic or Manual) with Provision for Radar Fix for CARP Calculation

To enable execution of the flight plan, all of the functions required by Figure 67 must have been performed. With alignment complete, the INS monitors aircraft movement and transmits signals to the software position update filter. The computed current position is compared with the next fly-to-point

(FTP) in the flight plan. Appropriate range and bearing computations to the FTP are calculated. That data is transmitted to the flight director and, if the aircraft is under manual control, the pilot makes the required control inputs. If the aircraft is under autopilot control, steering signals are provided for autopilot updating.

This SSD also illustrates how a terrain feature observed on the radar display can be "hooked" and designated for the computer as datum for calculating a navigation fix.

Figure 71: Execution of Flight Plan (Automatic or Manual) with Provision for Manual Fix

System activities shown in this diagram are similar to those of Figure 70 with the exception that the fix is based on a terrain feature visually acquired by either the pilot or copilot.

Figure 72: Execution of Flight Plan (Automatic or Manual) with Provision for Replanning

Again, the basic flow for this FSD is derived from Figure 70. The additive feature is the operator's interaction with computer using the IMK and MPD to accomplish a flight plan change. As noted, the change could involve a single, or multiple FTP input. When the points are accepted by the operator keying "ENTER", the computer selects the closest FTP as the next execution point unless another operator specification has been made. Steering commands are then generated for flight director display and autopilot use.

Figure 73: Standard Instrument Departure (SID)/Standard Terminal Area Requirements (STAR)

SID/STAR procedures are read into computer memory from standard mission tapes prepared for C-14 employment within specific theaters of operation. SID's are called up for display by manual IMK inputs. STAR's may be called in the same way; or, if desired by the flight crew, they may be automatically called when the INS senses that designated navigation parameters have been satisfied.

Figure 74: Course Offset (Based on Established Flight Plan)

This flow shows how the flight crew can preplan course offset which, when called, provides steering commands based on the stored flight plan.

Figure 75: Holding Pattern - Crew Configured

A holding pattern of any geometry can be set up by the flight-crew using this subroutine. The pattern may be configured in either of two ways. The

first involves inputting a series of LAT/LONG pairs to define the pattern limits, while the second would call for "hooking" terrain features on the moving map display in sequence, and designating those points as FTP's. For the latter, the computer converts the map points to LAT/LONG pairs for flight plan execution.

Holding Point Execution is shown on Figure 77.

Figure 76: Holding Pattern - Circular About an Input Point

By designating for the computer a center point (LAT/LONG or, alternatively, a "hooked" position on the moving map display) and a radius, the flight crew can establish a holding period in a minimum amount of time.

Figure 77: Holding Pattern Execution

This flow enables implementation of either of the previously discussed holding patterns. The software logic will implicitly provide steering commands for left-hand turns unless directed otherwise by the operator. Not shown in the flow, but important, is the requirement for a diagnostic routine to reconcile pattern parameters with commanded aircraft kinematics. Calculated output would provide the flight crew with resultant bank angles, turn times, g forces, etc.

Figures: 78, 79, 80, 81, 82: Station Keeping Equipment - Initialization

These 5 sheets indicate the input methods for the various parameters needed for SKE operation. The process is inter-reactive due to the number of options that are available to the operator in setting up the SKE. It is possible that this set-up could be preprogrammed for all aircraft participating in a sortie, but with the aircraft role differences from mission-to-mission, it seems hardly worth the added complexity.

Figure 83: Station Keeping Functional Operations

This flow summarizes all of the recieved and transmitted time based signals on which SKE operations are based. The way the signals are processed in automated functions, and the manner in which the refined data is employed is shown. Outputs are divided among those going to complementary elements in the integrated system for additional processing and use; and those which get subdivided into normal and alert messages for use in the displays group.

Figure 84: Set Up and Execution of Equipment Air Drops

An overview of interrelated functional requirements for precision air drops is shown on this flow. It tracks how integrated sensor system data (Naviga-

tion, SKE, and DZ Beacon) is used to set up modes of operation (auto and manual release techniques) with implementation functions facilitated by provisioned hardware (cargo door, tie down unlocking, and exit sequencing).

Figure 85: Automated Check Lists - Prepare for Inflight Refueling There are a large number of check lists, procedures, and performance data presentations that can be displayed by an IDAMST type system. Some are merely for crew reference purposes (aircraft performance check lists) while others require crew/system inter-reaction. A third type is the completely automated check list which is: (1) called and executed automatically after a set of conditions has been satisfied (gear up, flaps up, aircraft on climb power - execute after take-off check list, and report results); (2) called manually, but executed under computer control. Figure 85 is an example of the latter. Subsequent to operator call-up the software commands avionic subsystem control change, and reports the results out for Display.

Wherever check lists are called for by FSD's, Figure 85, the intent is that this figure represents a check list concept rather than the precise check list called for by the FSD element.

- Figure 86: Expendables Inventory and Management System Initialization

 Shown in this flow are the methods by which expendable quantity data is accounted for in the IDAMST system. The information is partially derived from sensed data with the remainder being supplied by operator input. As examples: fuel and oil filling is sensed; while cargo compartment loading is furnished via mission tape or crew input. Weight and balance reports are automatically up ated on a real time basis throughout the entire sortie.
- A real time aerodynamic analysis routine combined with the functions shown in the flow would be required to facilitate the operation of a full scale energy management system for the C-14. In its simplest operation, the concepts shown in Figure 87 would assist the crew during in-flight mission replanning, and assessments of safety margins. In the extreme, output data could be furnished directly to subroutines which could determine optimized weight distribution, control surface configuration, and power applications to produce maximum airplane performance in a given mission.

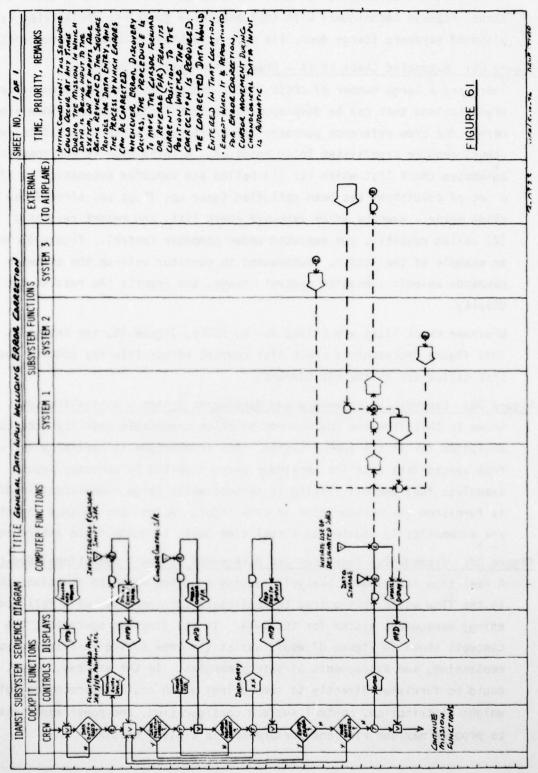


FIGURE 61: General Data Input Including Error Correction

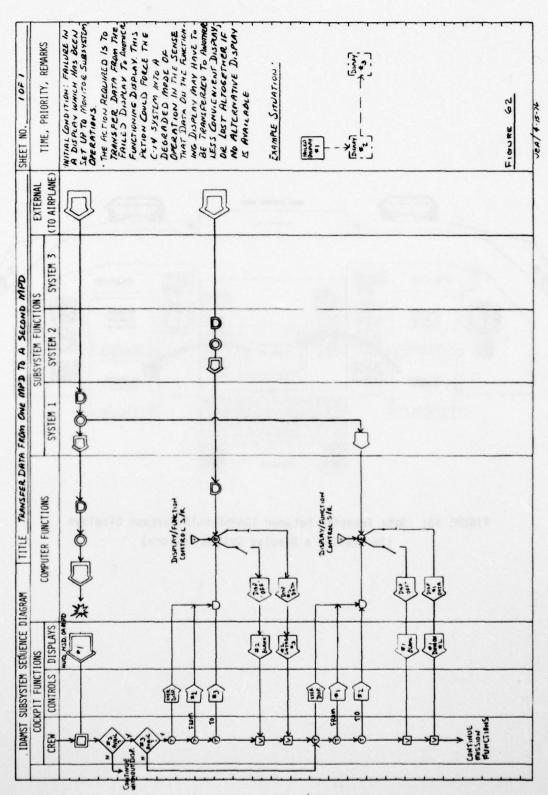


FIGURE 62: Transfer Data from One MPD to a Second MPD

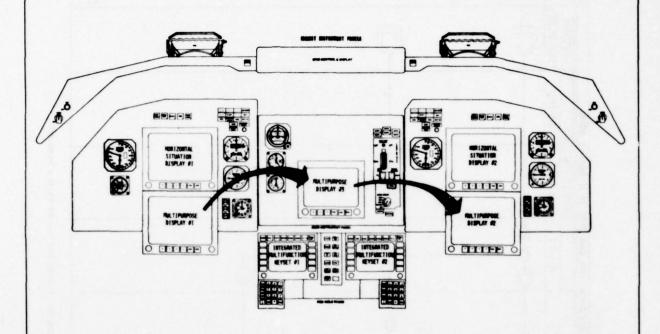


FIGURE 63: Data Transfer Between IDAMST Multipurpose Displays (To Resolve a Display System Failure)

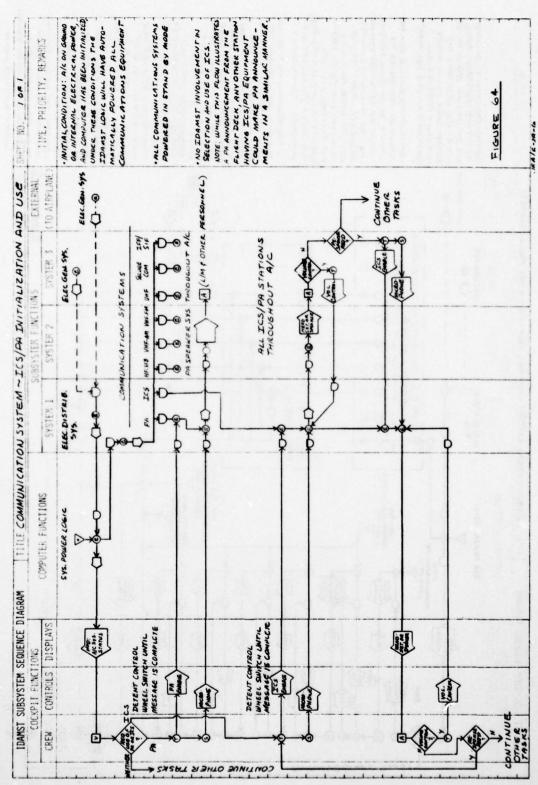


FIGURE 64: Communication System - ICS/PA Initialization and Use

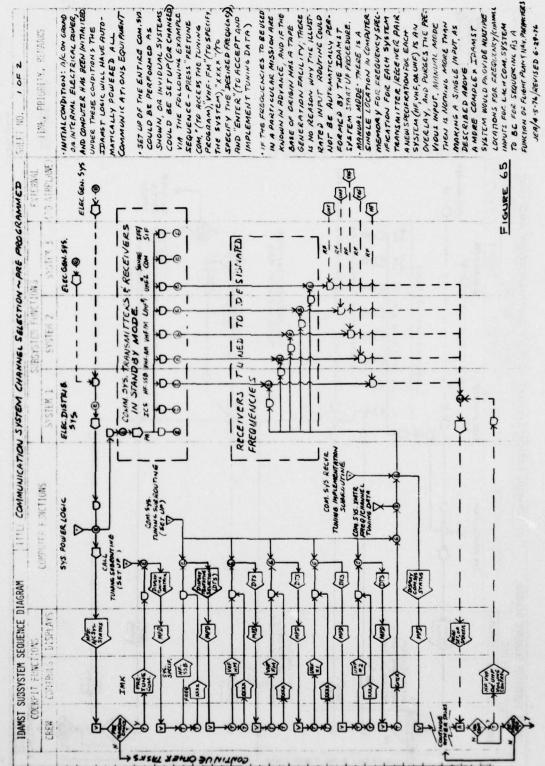


FIGURE 65: Communication System Channel Selection - Preprogrammed

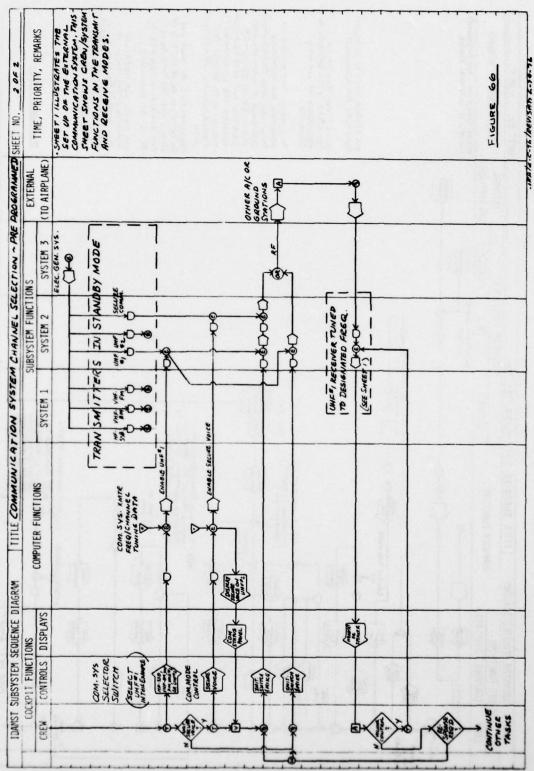


FIGURE 66: Communication System Channel Selection - Preprogrammed

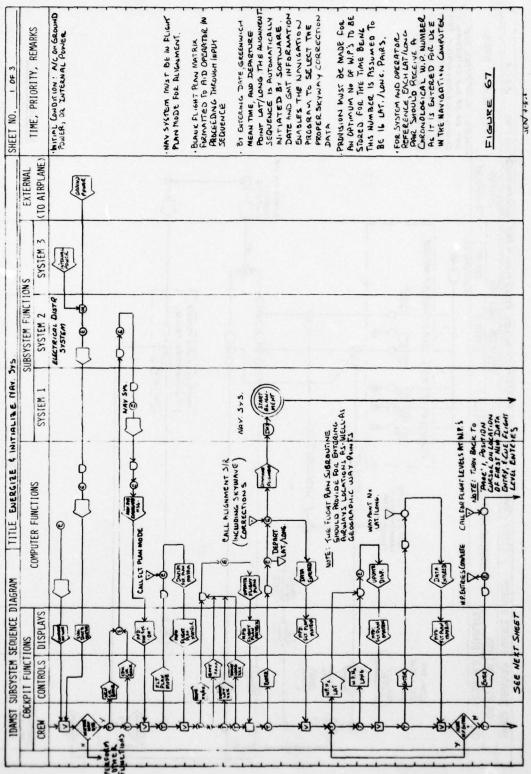


FIGURE 67: Energize & Initialize Nav. Sys.

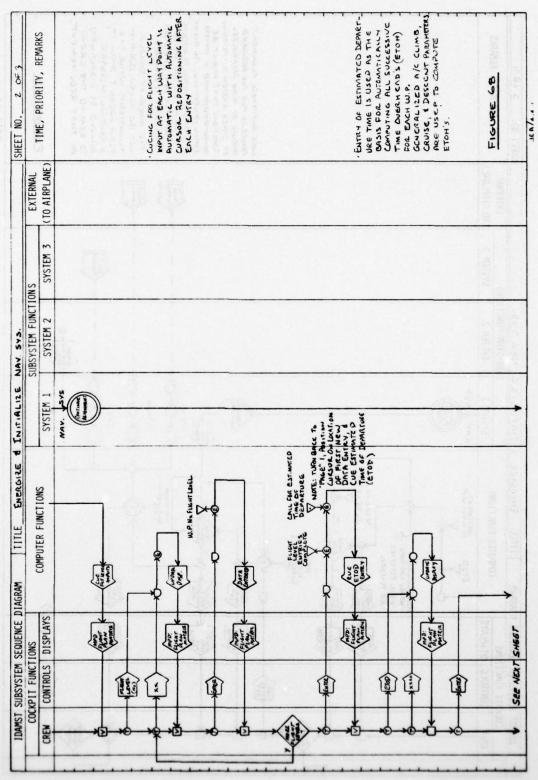


FIGURE 68: Energize & Initialize Nav. Sys.

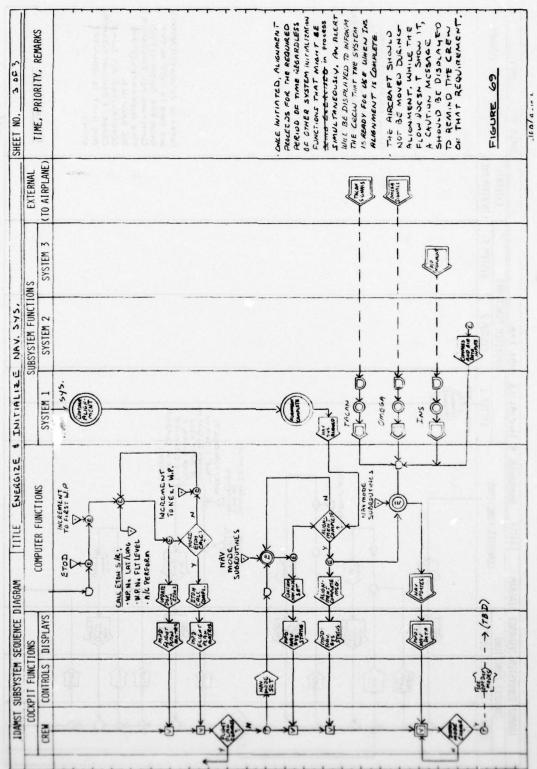
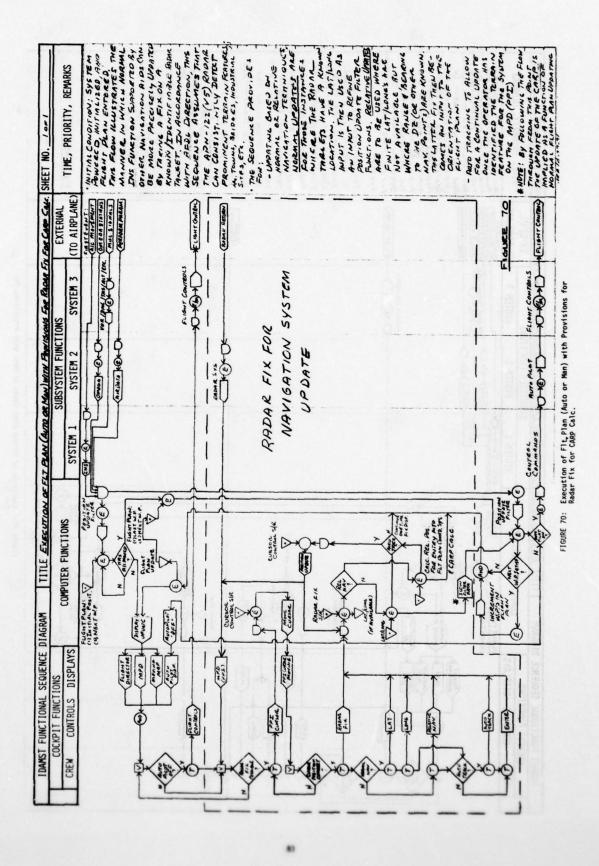


FIGURE 69: Energize & Initialize Nav. Sys.



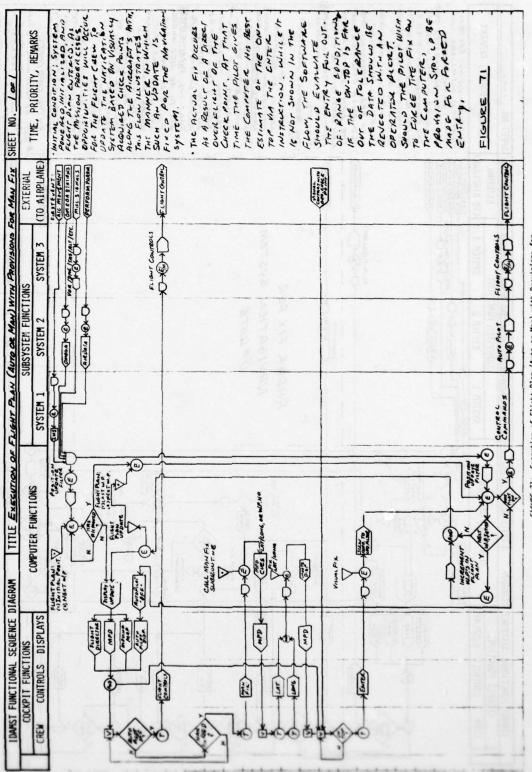


FIGURE 71: Execution of Flight Plan (Auto or Man) with Provisions for Man Fix

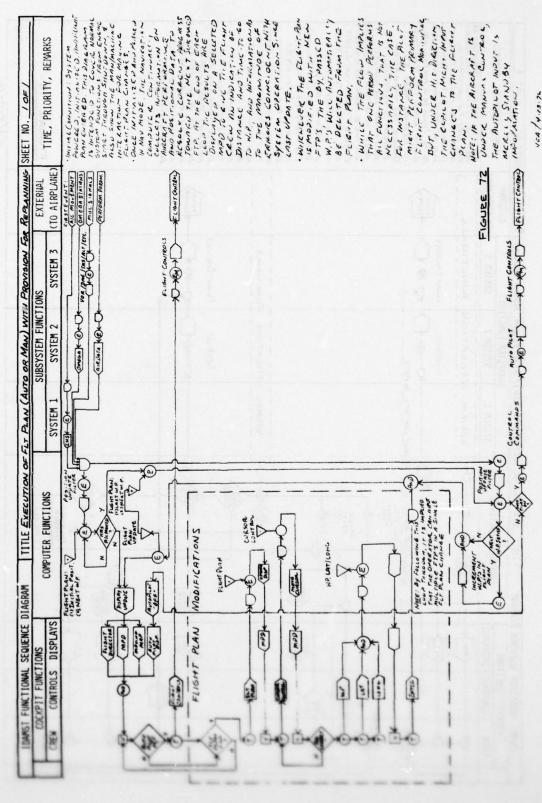
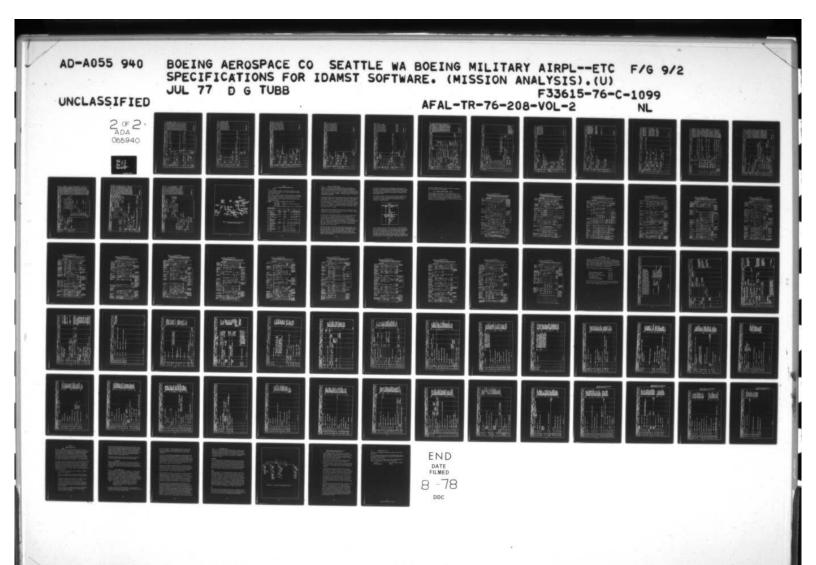
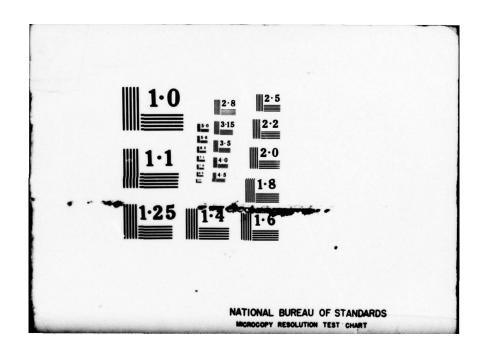


FIGURE 72: Execution of Filt Plan (Auto or Man) with Provision for Replanning





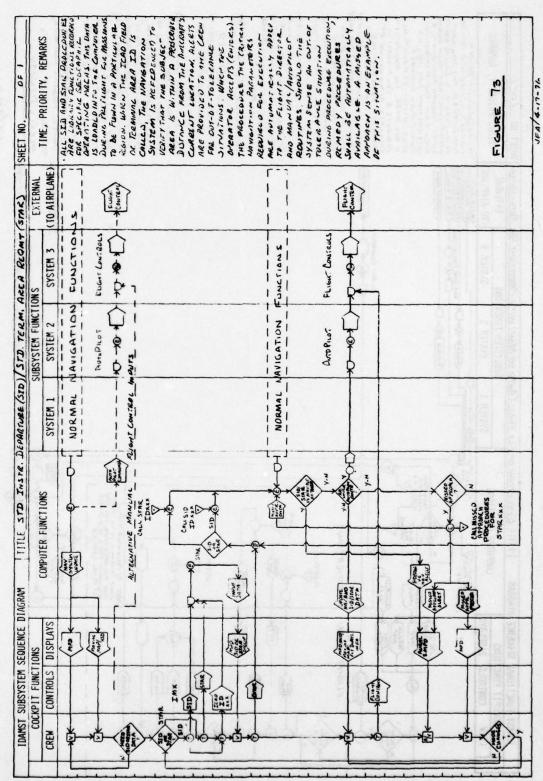


FIGURE 73: Std. Instr. Departure (SID)/Std. Term. Area Regmt (STAR)

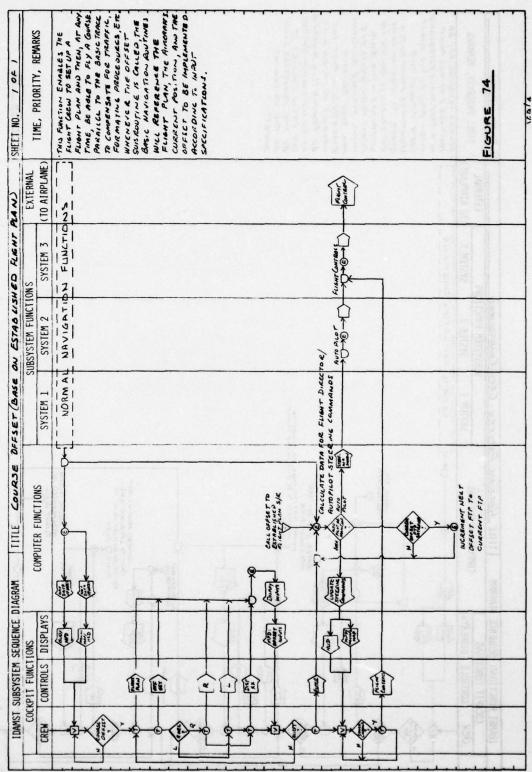


FIGURE 74: Course Offset (Base on Established Flight Plan)

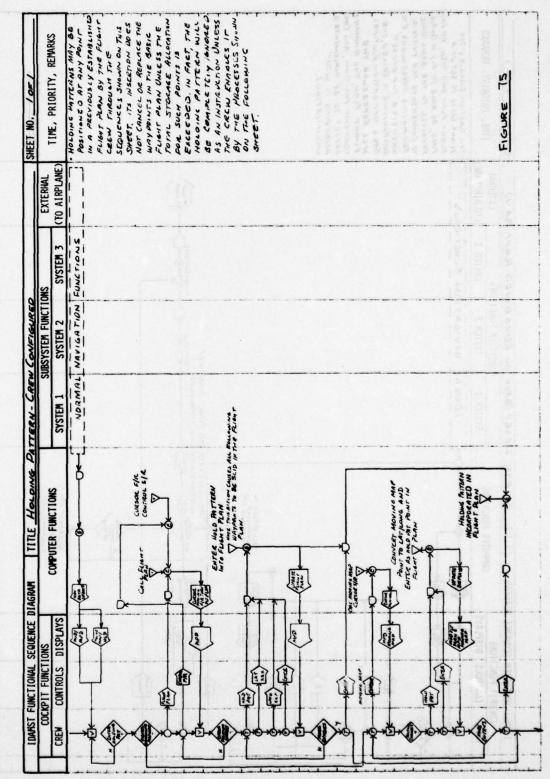


FIGURE 75: Holding Pattern - Crew Configured

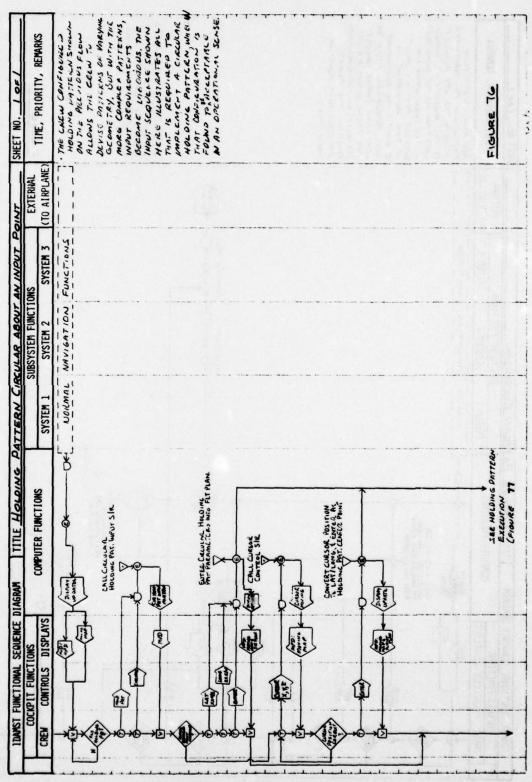


FIGURE 76: Holding Pattern Circular About an Input Point

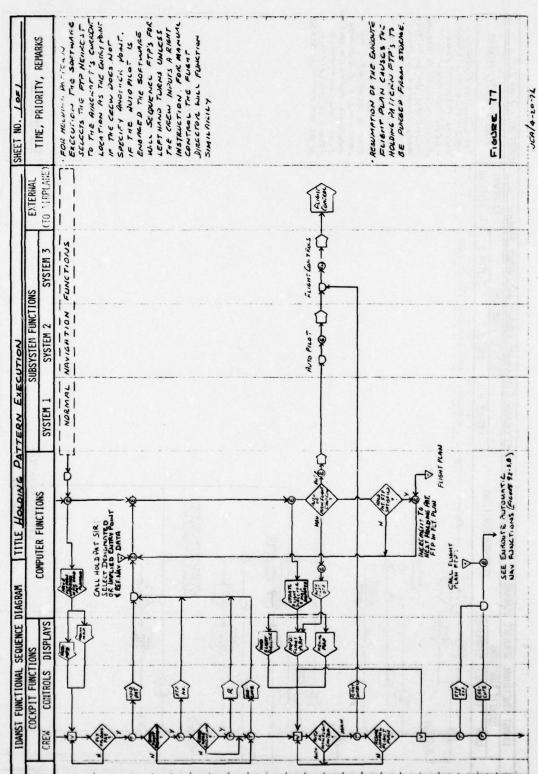


FIGURE 77: Holding Pattern Execution

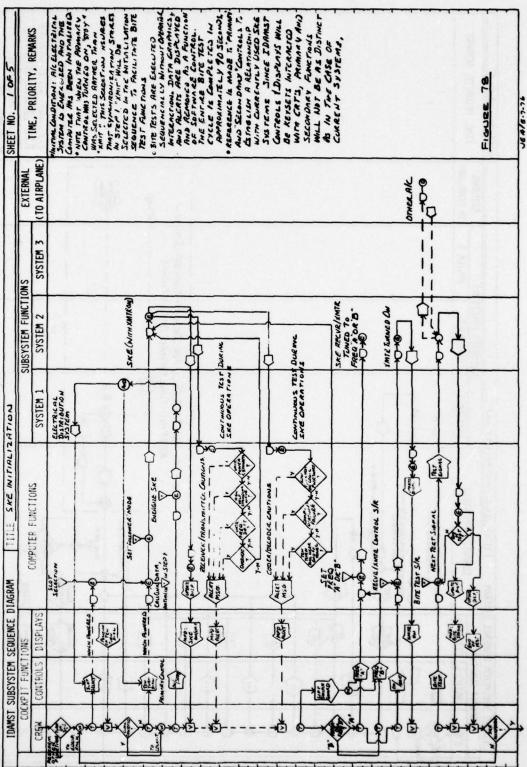


FIGURE 78: SKE Initialization

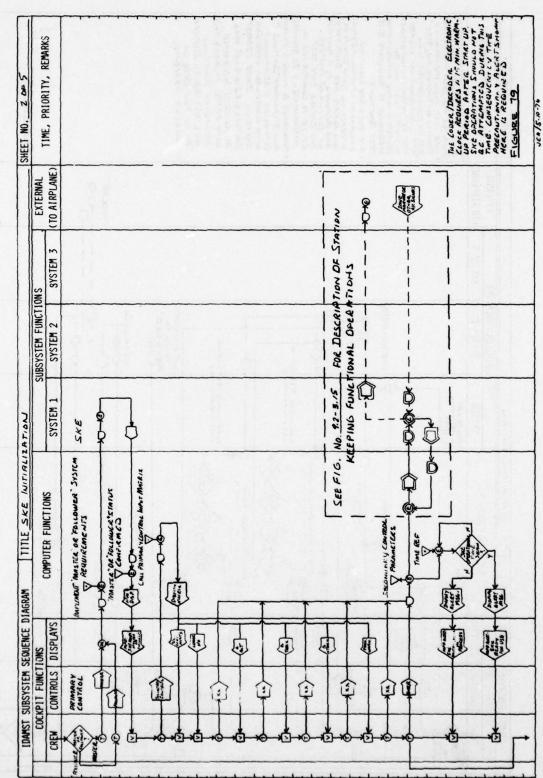


FIGURE 79: SKE Initialization

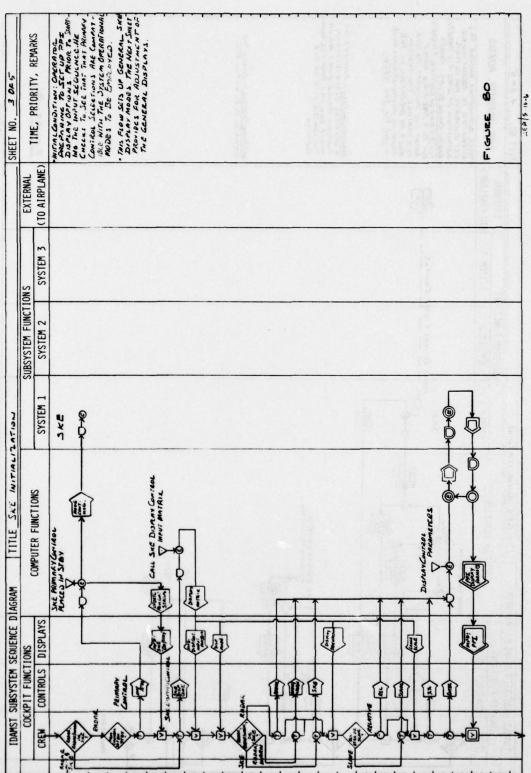
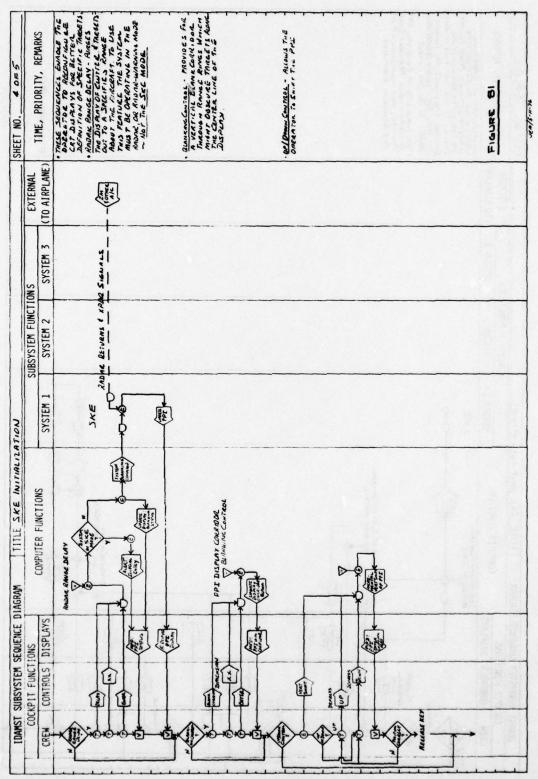


FIGURE 80: SKE Initialization



FIGUR 81: SKE Initialization

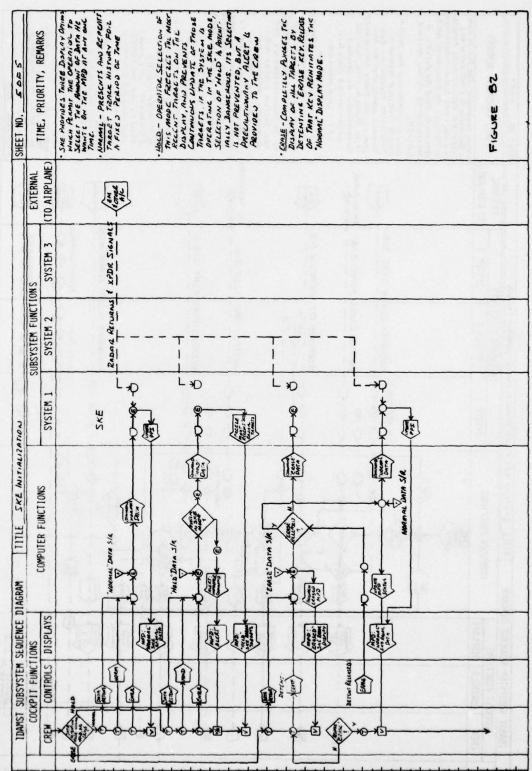


FIGURE 82: SKE Initialization

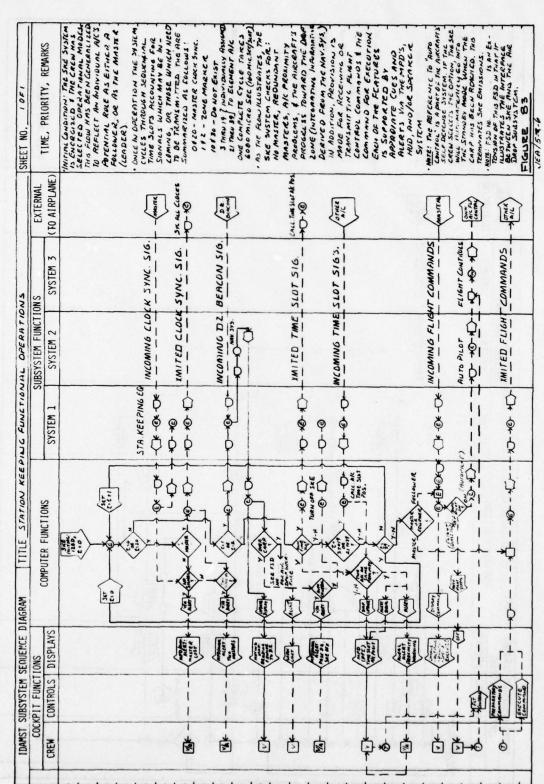


FIGURE 83: Station Keeping Functional Operations

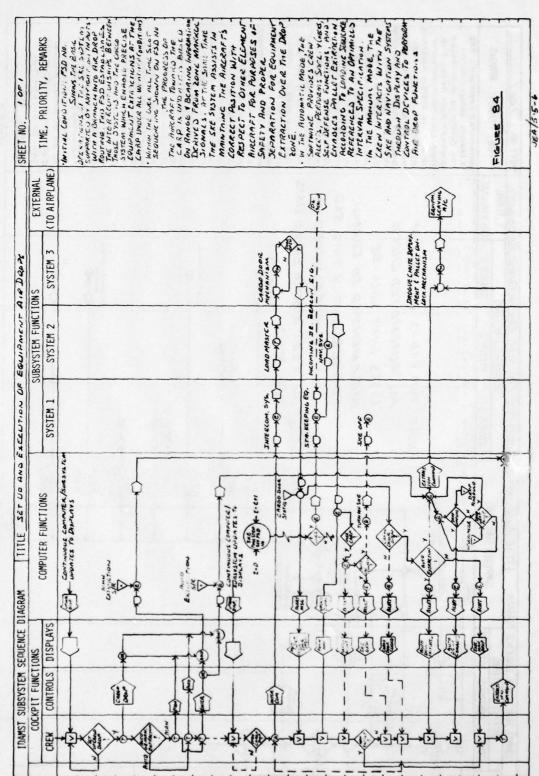


FIGURE 84: Set Up and Execution of Equipment Air Drops

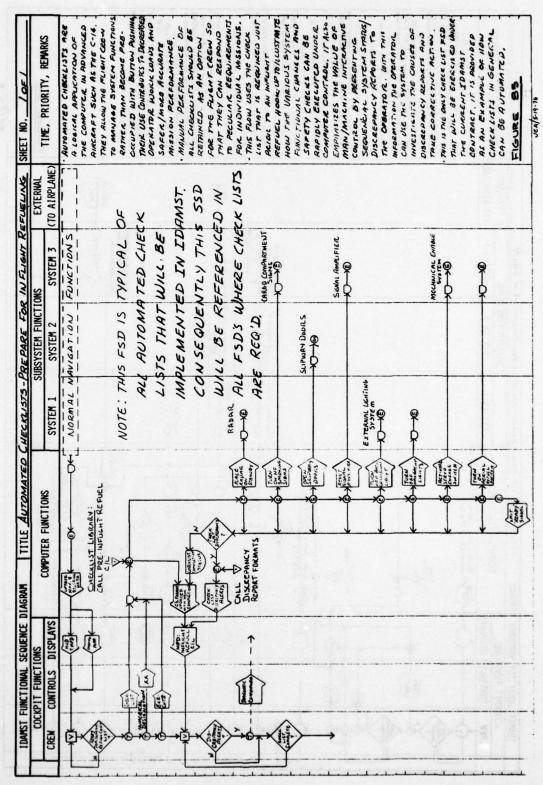


FIGURE 85: Automated Checklists - Prepare for Inflight Refueling

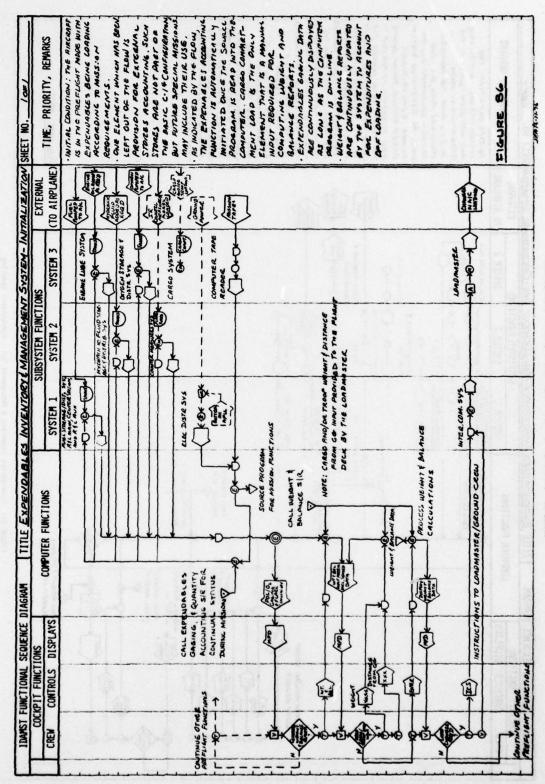


FIGURE 86: Expendables Inventory & Management System - Initialization

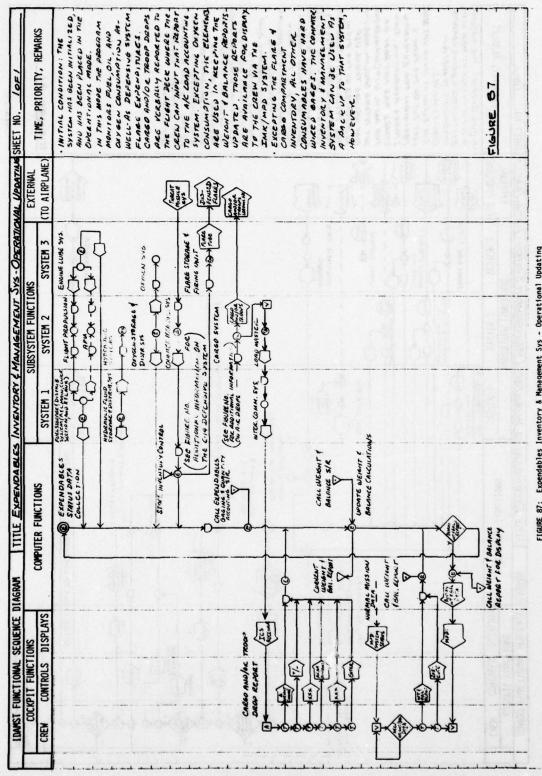


FIGURE 87: Expendables Inventory & Management Sys - Operational Updating

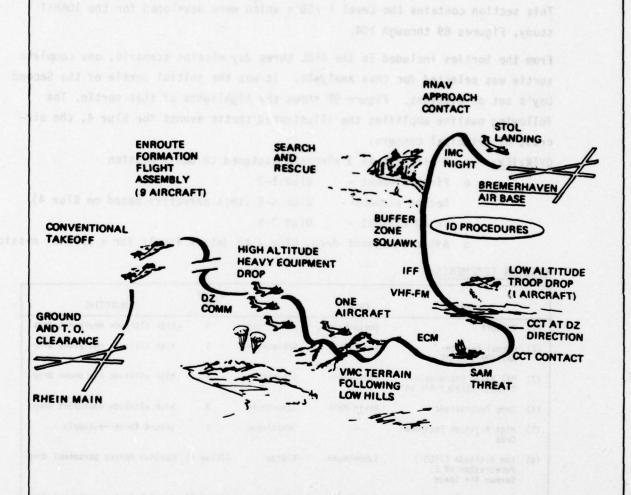


FIGURE 88: Mission Events Covered by Level One FSD's (First Sortie of the Second Day)

SECTION V LEVEL 1 FUNCTIONAL SEQUENCE DIAGRAMS (FSD'S)

5.1 OVERVIEW

The Technical Approach, Paragraph 2.1, introduced and defined Level 1 FSD's. This section contains the Level 1 FSD's which were developed for the IDAMST study, Figures 89 through 104.

From the Sorties included in the AFAL three day mission scenario, one complete sortie was selected for this analysis. It was the initial sortie of the Second Day's set of missions. Figure 88 shows the highlights of that sortie. The following outline amplifies the illustrated sortie events for Blue 4, the aircraft of principal concern:

OVERVIEW: o 9 aircraft in 3 elements assigned to basic mission

o First element - Blue 1-3

Second element - Blue 4-6 (this narrative based on Blue 4)

Third element - Blue 7-9

o After equipment drop, Blue 4 to detach itself for a special mission.

MISSION SEGEMENTS:

	EVENT	FROM	то	NO. OF	OBJECTIVE
(1)	Takeoff	Rhein-Main	Schoningen	9	high altitude equipment drop
(2)	Normal Enroute NAV/COM/IFF/ATC	Rhein-Main	Schoningen	9	high altitude equipment drop
(3)	Mil Radar Coordinate THREAT/FRIENDLY A/C DATA	Rhein-Main	Schoningen	9	high altitude equipment drop
(4)	Drop Preprations	Rhein-Main	Schoningen	9	high altitude equipment drop
(5)	High Altitude Equipment Drop		Schoningen	9	ground force re-supply
(6)	Low Altitude (1500') Penetration of E. German Air Space	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(7)	Drop Preparations	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(8)	Request and Receive Airborne ECM Support	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(9)	Special Forces Personnel Drop	-	Klotze	1(Blue 4)	Covert operations
(10)	Enroute Transit, and Repeat (2)	Klotze	Bremerhaven	1(Blue 4)	Recovery
(11)	Search and Rescue Related to Downed F16	Klotze	Bremerhaven	1(Blue 4)	Search and Rescue
(12)	Landing		Bremerhaven	1(Blue 4)	Sortie completion

5.2 LEVEL 1 FSD FORMAT ELEMENTS

The level 1 FSD formats have been configured to show to the largest extent possible, the simultaneous crew/system functions occurring in scenario time blocks. Provision has been made to illustrate interactions of the two-man flight crew with the various aircraft subsystems. As appropriate, the flow defines which system commands are hardwired as opposed to those whose interface is facilitated through the software medium.

The dedicated headings on the format allow the analyst to call the most frequently used subsystems, specifically - "Communications", "Navigation", "Flight Controls", and "Sensors". Notes on each application give the specification as to which type of equipment in the subsystem is being used. The "other" heading is included to allow for references to less frequently used systems and functions in addition to actions of the loadmaster. For reference to events or signals which influence Blue 4's mission activities, and which have their origins outside the aircraft, the "External" column is included.

"Operator Notes" amplify the crew activities called for in the scenario, while "Software Notes" provide information pertaining to computer interface of hardware subsystems with the display and control suit.

For each scenario event depicted on the level 1 FSD, flow lines briefly outline the systems which are involved in accomplishing the required functions. The "Figure" numbers, which appear on the horizontal lines, reference the more detailed man/machine/software relationships defined by the Subsystem Sequence Diagrams. A number of Figure numbers are accompanied by a "To Be Determined (TBD)" note. This indicates that the FSD analysis has identified an SSD requirement which remains unsatisfied as this study comes to a close. That work must be completed as part of a future effort.

The time blocks shown in the left hand column index FSD events to those of the AFAL narrative scenario. Only a rigorous simulation of the IDAMST system could provide the basis for an accurate workload assessment. But reference to FSD time-blocks together with cooperative two-man crew functions linked to the magnitude of SSD processing gives the analyst an intuitive feel for man/machine loadings in each mission mode.

Definitions for the symbols used in FSD development are provided by Table 3. Since Level 1 FSD's are merely an outline of mission events intended to provide only superficial detail, some symbols are used more than others. Storage and recall of data along with the decision logic notation are infrequently used in the development of FSD's.

The direction of activity flow on both the FSD's and SSD's is generally from top to bottom. But where a repetitive man/machine interaction occurs (as in communications, for example), the device of illustrating the flow with a closed loop is frequently employed.

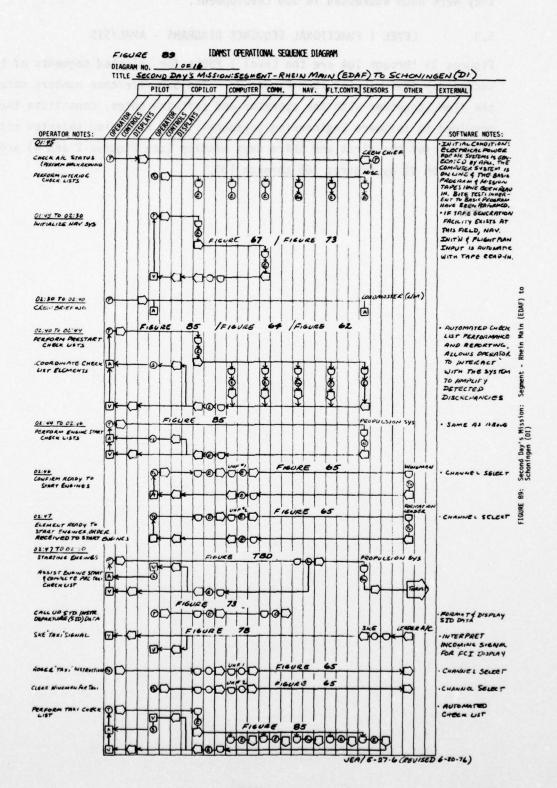
	TABLE 3 FSB/SSB Symbology
THE FOLLOWING SYMBOLS SYMBOL	ARE USED IN DEVELOPING FSD'S AND SSD'S:
0	RECEIVE
ŏ	ACT
	MONITOR
0	TRANSMIT
∇	STORE DATA
Ÿ	RECALL DATA FROM STORAGE
Ŏ	DECISION LOGIC
FUNCTION IS CO	L (), FOR EXAMPLE) MEANS THAT THE NTINUOUSLY PERFORMED INFORMATION USED WITH SYMBOLS:
LEGENO	MEANING
A market A market	AURAL
E	ELECTRONIC/ELECTRICAL
R STREET, STREET	MECHANICAL
militab a Filan	RADIO FREQUENCY
\$	SPEECH
T	TOUCH
el entrapidad	VISIAL

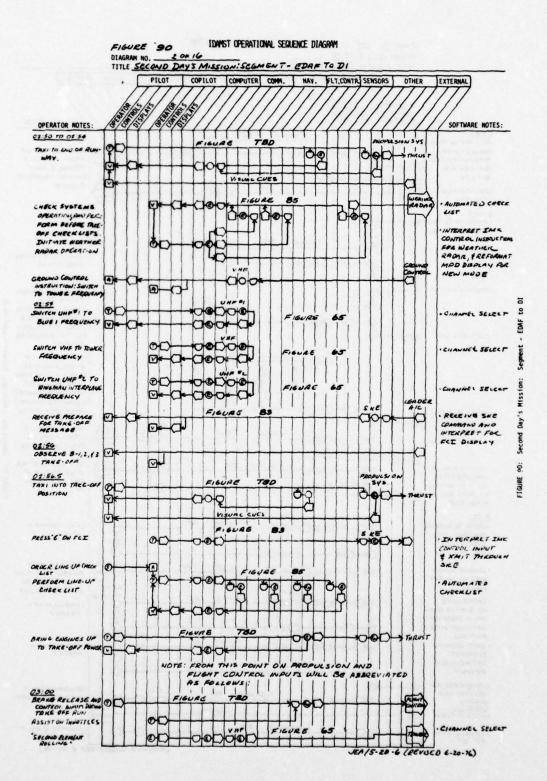
It will be noted that the Level 1 FSD's do not call all of the SSD Functions which are included in Section IV. This occurs because the SSD's were generated with a narrow view toward defining aircraft multimode functional capabilities. While most of these capabilities were called for in the scenarios, not all were because the aircraft was never operated in that mode. As an example, the IDAMST navigation system is based on R-NAV concepts which include provisions for course offsets as well as holding patterns. The scenarios did not call for

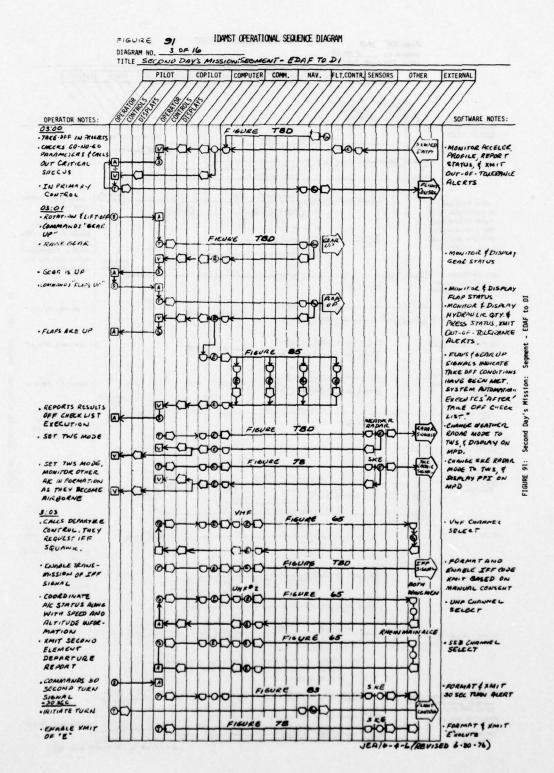
these, but the IDAMST software must provide the capability. Consequently, they were both addressed in SSD development.

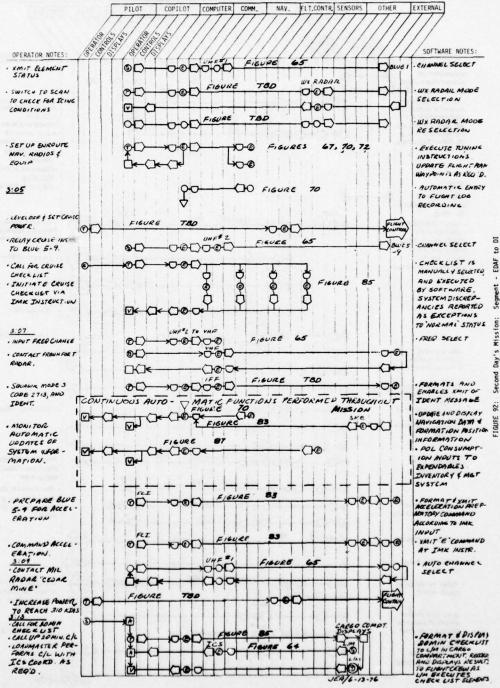
5.3 LEVEL 1 FUNCTIONAL SEQUENCE DIAGRAMS - ANALYSIS

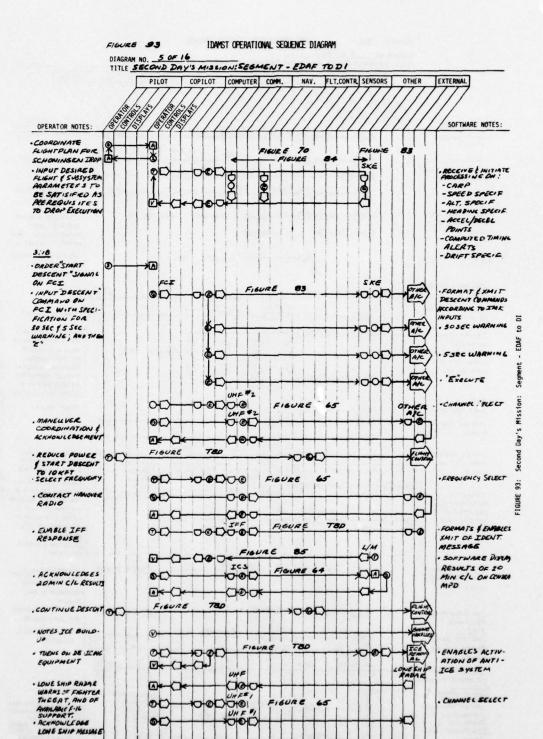
Figures 39 through 104 are the Level 1 FSD's for selected segments of the second day AMST mission (See Figure 3). The SSD reference numbers noted on the flow, together with the operator and software notes, constitute the analysis provided to software Engineering personnel. The remaining selected mission segments for the first and third days mission (see Figures 2 and 4) are provided in Section VI by Figures 105 through 135.









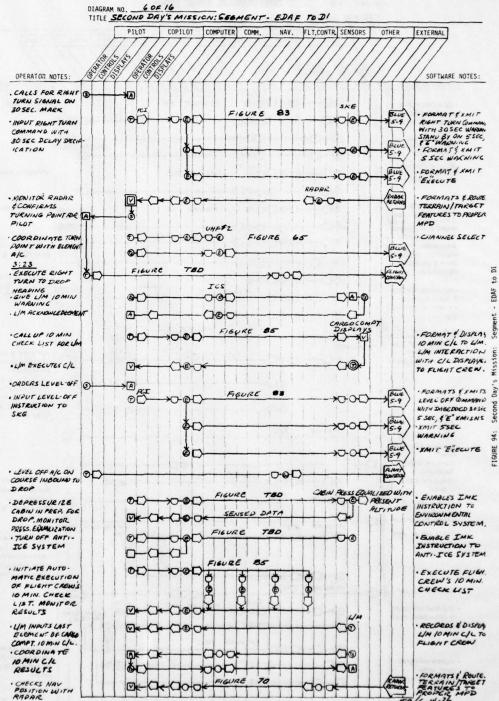


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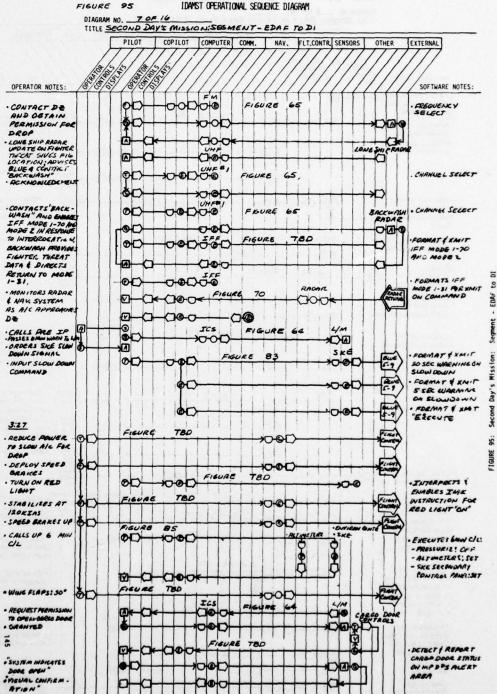
FIGURE

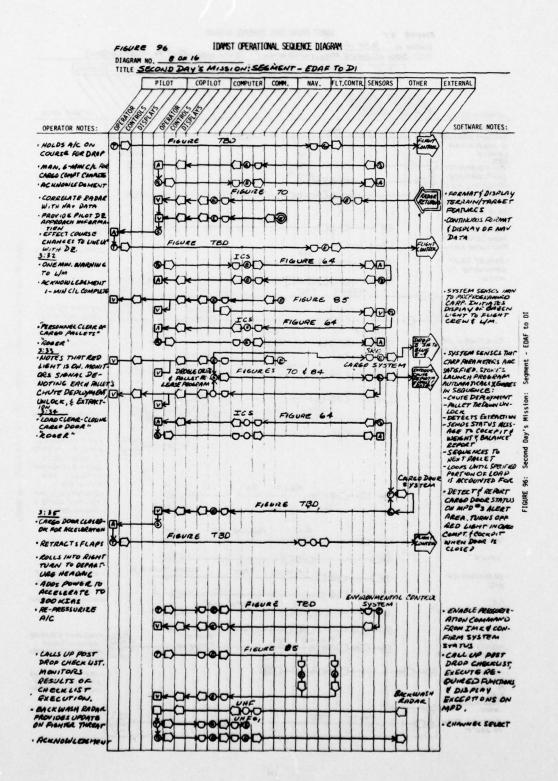
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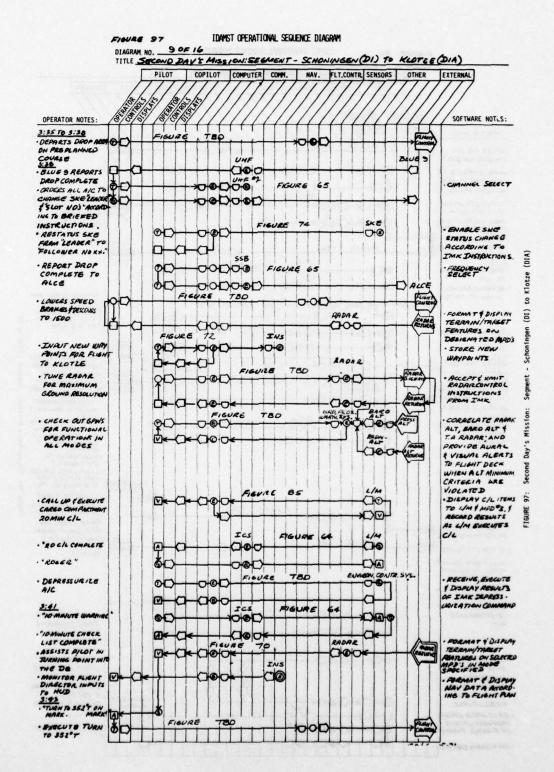
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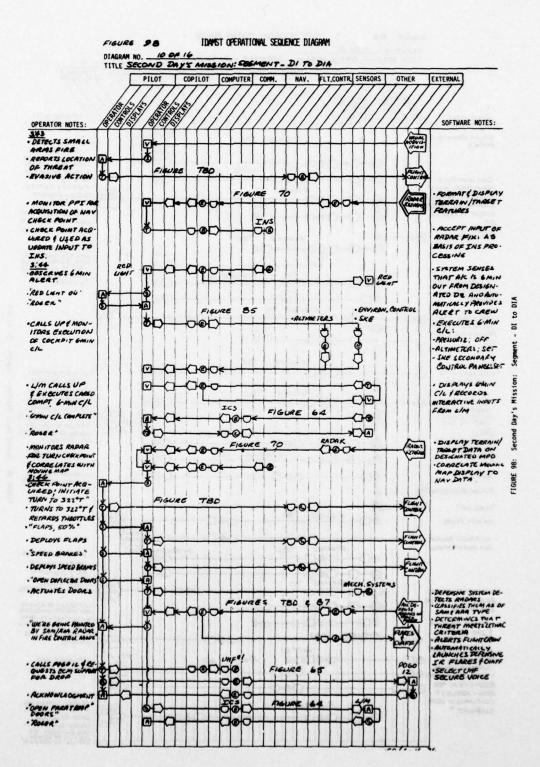


IDAMST OPERATIONAL SEQUENCE DIAGRAM

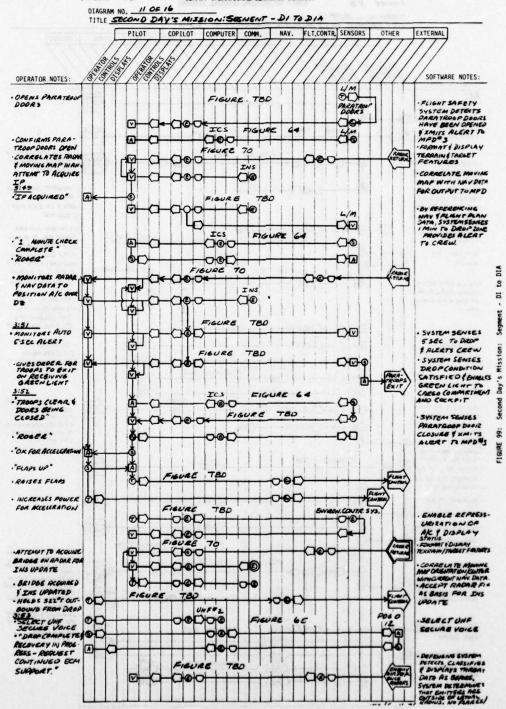




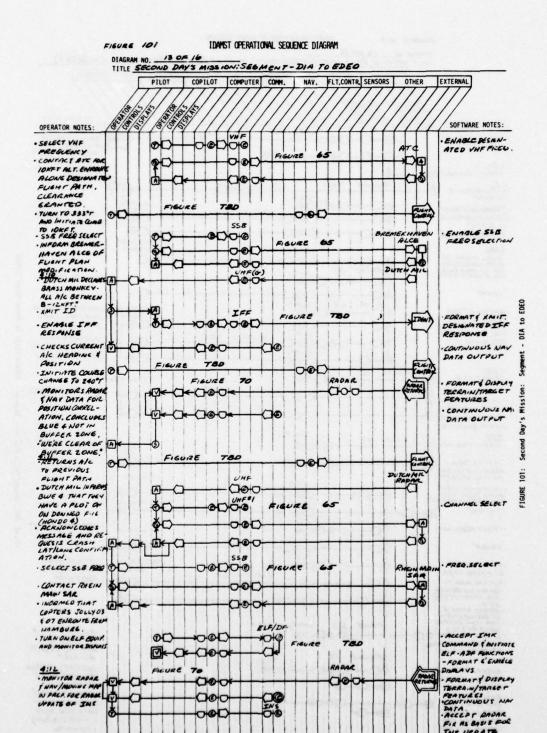




IDAMST OPERATIONAL SEQUENCE DIAGRAM

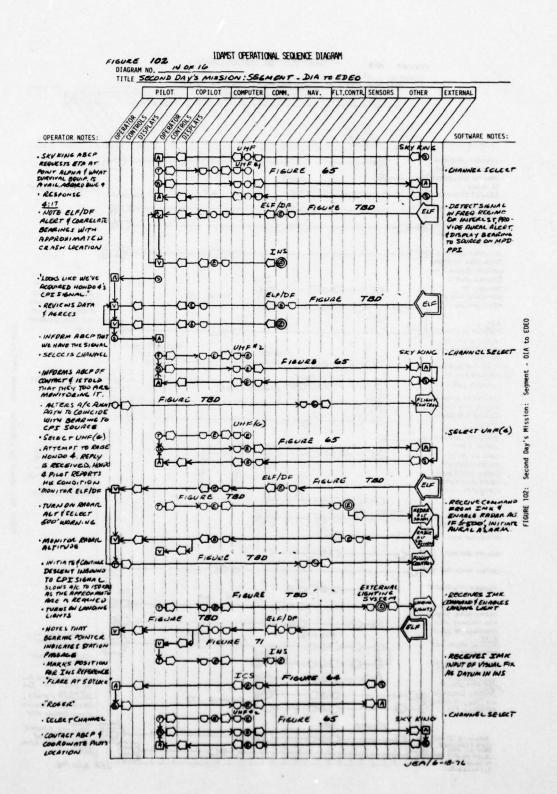


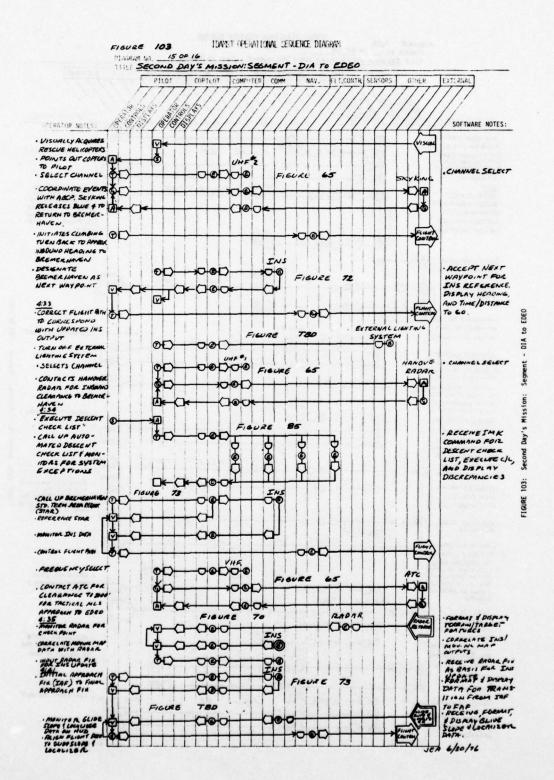
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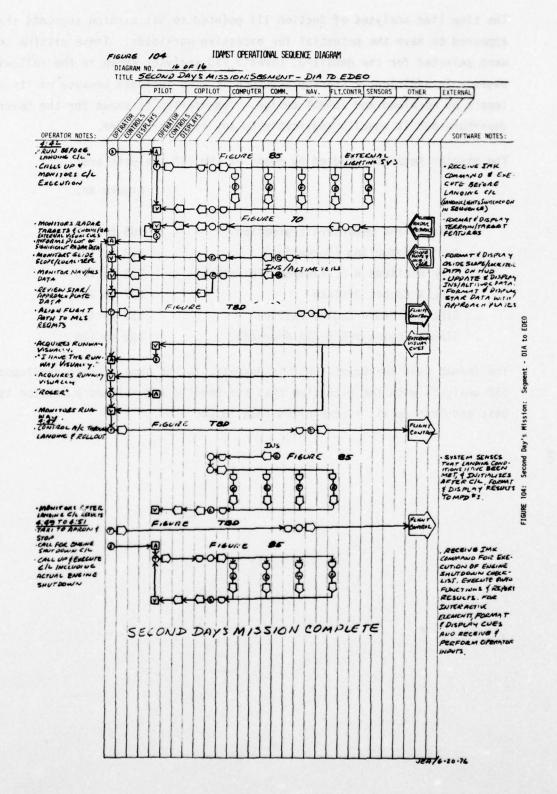


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SECTION VI LEVEL 2 FUNCTIONAL SEQUENCE DIAGRAMS

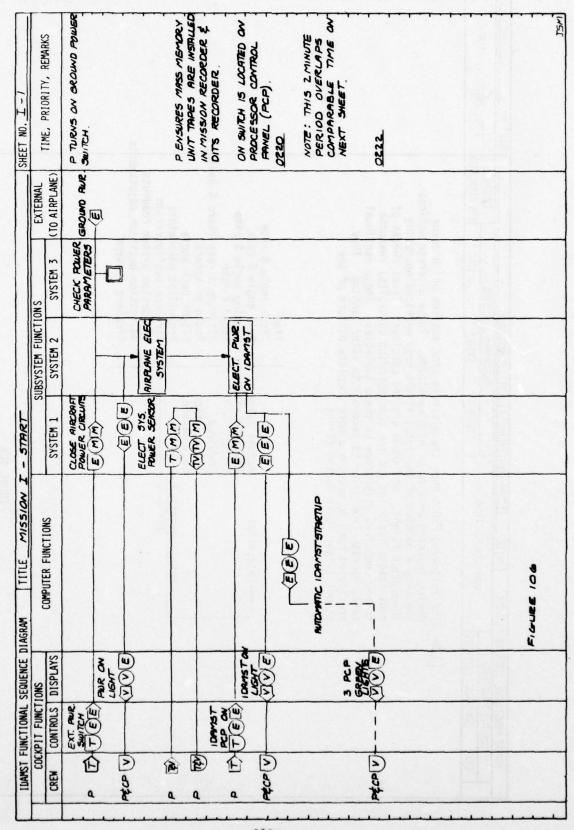
The time line analyses of Section III pointed to six mission segments that appeared to have the potential for excessive workloads. These mission segments were selected for the detailed, Level 2 FSD analyses shown in the following pages. In addition, a startup sequence is also included because of its potential impact on workload and IDAMST design. The startup is shown for the Dover AFB departure but is equally applicable to any start procedure.

The mission segments studied by means of the FSD analysis are:

	Figure	No.
Startup and Departure (Formation)	105 to	117
Aerial Refueling (Formation)	118 to	121
High Altitude H.E. Airdrop (Formation)	122 to	126
STOL & Combat Offload	127 to	129
STOL Departure Engine Failure	130 to	131
Single Engine VOR & ASA Approach	132 to	135

The format used for Level 2 FSD is essentially the same as that developed for SSD analysis with the exception that the Level 2 FSD follows a mission time base and less detail is exhibited than in the SSDs.

SHEET NO		tts	
EXTERNAL (TO AIBPLANE)	r tions g of se ual	te aro & Radi ers tion readouts n adjustmen	
IDANST FUNCTIONAL SEQUENCE DIAGRAM TITLE TOONTINUAL FLIGHT FUNCTIONS COCKPIT FUNCTIONS COCKPIT FUNCTIONS CORPUTER FUNCTIONS SYSTEM 1 SYSTEM 2 SYSTEM 3	The following FSD's show the discrete crew actions which occur during selected periods of high workloads. These discrete actions are only a portion of the total flight crew workload operating throughout flight. Not shown are the continual visual checks of many flight variables and the corresponding control(s) response to any undesired divergence of these variables. These continual tasks operate from prior to take-off to after landing. They are listed here to provide a more complete picture of the actual flight tasks during flight.	Determine: . Actual value . Pitch angle & rate . Required value . Reding angle & rate . Error . Required . Altitude & rate . Required . Altitude & rate (Baro & Radid) . Correction . Best method . Flight path angle . Propulsion parameters . For	FIGURE 105



SHEEL NO. 4-6	TIME PRINRITY REMARKS		0220	The same	PERIOD OVER LANS THE	PRIOR SHET.		Section of Statement Section 1	Communication approximate to the communication of t	WITH 3 K.P INDICATOR	KNOWE IDAMST IS LANGED AND REPORTE	NING CONT SALT WITH	COPILOT CHECKS KS WITH LONDYPOSTER. LUI RESPONDS & GITS	OLO MAN	Can county the Charter on	CIRCUIT DEMENS	75.00
	EXTERNAL	(TO AIRPLANE)					OCT. NSON	Ð	<i>3</i> 4							MAN WAR	
	ONS	SYSTEM 3										" MONR					
	SUBSYSTEM FUNCTIONS	SYSTEM 2				DUNES					73 65, 66	08 1				Enert	
- STAKT		SYSTEM 1	- RIT DECK	STOWNER	FUENT CHE	¢nower staw	D.	3	€.		i i i	į	SOE	1		EUT BROWER ECIDED INFROM CUMBERSONE EMERGILLY W.	1
AGKAM TILLE MISSION L	COMPLIED CHRISTIANS	CURTULER FUNCTIONS	BOUND CHEKED & STOWED	BERR HANDLE PERTON \$ LEATS CHECKED	CHARTS & MANUALS CHECKED		SENT AQUATMENT	DISPLAY WSON	RIDDER FEDAL ADJUST	T" MSTER MODE		MIK)	1 INTERCOM SYS. (KS)		ast"	MAN MED DISPLAY OF CIRCUIT DISPANSE STATUS WOULD BE A DECIDED IMPROVED OVER THE PRESENT CHIPBLESCAME.	0
DAMS FUNCTIONAL SEGUENCE DIAGRAM	IONS	CONTROLS DISPLAYS	COCKPIT & NOTSOWAL	BAK HANGL	AT O			STEP STEP		STR	30	(AND MSD IMK)		1 .	20		
FUNCTIONAL	COCKPIT FUNCTIONS	CONTROLS	COCKPIT	E E					TOR	1				1.000	P 2 3	SO IS	
ILIAMS	000	CREW	200		A ST	3				5	1 2	>	8 5	5			

SHEET NO. L-3	TIME, PRIORITY, REMARKS			CP CALLS UP COM" ON	IMK 2.	SINTUS (MPD-E) THAT ARDI	USTED.	CP CAUS UP LINE "ON	IMKE.	8	THE MODE		STATES AND A STATE OF THE STATES	CP CONTRCTS BLUE 546.	STARTING CHECK PROCEDURE	SIMILAR CONTRCT WITH	CHECK STARTS CHECKST	· ELBETTOCAL SYSTEM	. HYDERULE SYSTEM	. PRESS, EMMEN. &	. FILE OND SYSTEM	· PRIMARY COMPAS	SECONOMEY CONTROLS	. AIR DROP SYSTEM	FUENT DOPLAYS	CP SEECTS SKE PINCES ON	I'M. CALLS UP SKE DISP.	"TIME UP'OF SEE SYS
	EXTERNAL	(TO AIRPLANE)												1		•												
	N.S	SYSTEM 3															 											
	SUBSYSTEM FUNCTIONS	SYSTEM 2														(E) (E) (E)]		Devreeding									MSD 2.
I - START		SYSTEM 1								1	IME ONE IN	TA NOOE	300	3 6 6	(CSE LIME)	\$3.6€ (\$1.0€	1		A CONTRACTOR OF									CP SELECTS "SKE" ON HSD 2.
THE MISSION	COMPLITER FUNCTIONS	20011200		E SELECT (MK) E E	ŢŪ,	COMM SIATUS					COMM. MODE SELECT (MIX)	,	IMK-Z INDICATE LIHF ON & IN THE MODE		EXTERNAL RADIO CONTRCT (State and the state of the stat			(S) CHEKUST			39 FLEC	T IMK SKE	FOTS "HSD" E	ON HSD 2	MODEL DIEG BY		
IDAMSI FUNCTIONAL SENDENCE DIAGRAM	COCKPIT FUNCTI	CREW CONTROLS DISPLAYS	1	CP UTUEE (2.) PRO	CP V VVE	100-1	í	8 W	\$ (V.)	Co Contract	(3)	S VVVE	42-00W	80	(£)	Atch A	CP TT FE	-	M. M	CHECK " CHECKUST DISPLAY	£		5	W TIEVE	Second Second		CP IT TEE	2

COCKPIT FUNCTIONS COCKPIT FUNCTIONS CHEN CONTROLS DISPLAYS CHEN CHEN CONTROLS CHEN CHEN CHEN CHEN CHEN CHEN CHEN CHEN
MIOIH!

SHEET NO. 1-5	EXTERNAL TIME, PRIORITY, REMARKS (TO AIRPLANE)	0236 BLUE 4 RECEIVES CALL FROM BLUE FIGHT LEAD.	READY FOR ENGINE STATI, AMATTHE CLEARANGE. LIM REPORTS PAYLOAD SECURE, OFFICE COMPLETED. CP ACKS. DOVER GROUND COMPOL AN EVER GROUND COMPOL AN EVER GROUND COMPOL		SID ON HSD 2. 0240 BLUE FLIGHT LEADER CLEARANCE. BLUE 5 & 6 ACKNOWLEDGE TO BLUE 4. BLUE 4 ACKNOWLEDGES BLUE 4 ACKNOWLEDGES	BLUE FLIGHT LEADER. CP ALERTS GRND. CREW FOR ENGINE START. CHIEF REPORTS READY PACP BRAKES A ATREMAT	SYSTEMS SET FOR ENGINE START P CHECKS BLEED AIR >30 PS1. ALERTS GROUND CREM TO IMPENDING START.		PATI-COUSION
	ONS SYSTEM 3			RECORDER FFUL AID MESSAGES.				ET SENSOR	
	SUBSYSTEM FUNCTIONS SYSTEM 2			E VOICE (1CS) RECORDER TO BE A USEFUL AID AND SIMILAR MESSAGE				BLEED MR DUST 36450R	
- SIARI	SYSTEM 1			POPENES		1 9		(END CREW)	
DIAGRAM LILLE (TIBSION L	COMPUTER FUNCTIONS	DIO CONTRET)	80m 58.)	- RADIO CONTRETS)	: SELECT-IMK) KZ USED TO PRESENT SID HSD 2.	(EXTERMAL RADIO CONTACTS)	conn srs.)	ECOT SYS) "CLERR NO. 2." NO. 2. CLERR" (GND CREW) (E)(F)	
SCHUENCE	10NS DISPLAYS	באשר עש	1. (INT	4. (EXTERNAL	ار <u>ه</u> آ	4. (EXT	1 (mm	I. (ME)	
INATES FUNCTIONAL SEGUENCE DIAGRAM	CREW CONTROLS DIS	PRCP A 4. (EXTE	 M © M 5 8 8		\$ €		→ (n) (e) (b)		CP ET TEE

SUBSYSTEM FUNCTIONS EXTERNAL SYSTEM 3 (TO AIRPLANE)	ENGINE E PORTO NO. 2 BLEED AND SERVICE OF THE PORTO NO. 2 BLEED NO. 2 BLEED AND SERVICE OF THE PORTO NO. 2 BLEED AND SERVI	M	MO Z BROWE RET JORGE MO E BLEED MO E BLEED MO E BLEED	25081	-
			(E(E) E TORES NOT DECARTS (FOST SATOON BANNE) CONTINUE FIOTORING NO. 1. ENGINE	NO CONTRET (STRETE UP S EXTENSIVE	CANDONE FOR P.

SHEET NO. L - 1	TIME, PRIORITY, REMARKS	. 8	TO ENGINE GENERATORS WYD. STS. WYD.	OS44 SELECTS "TAKE-OFF" MASTER HODE. BISHLAY CONTENTS & STATUS CHCKED. COLLES BAUE & B FOR READY TO TAKE BY. CO REPORTS BAUE & ELENBET READY TAKE. CO REPORTS BAUE LEAGER PACH RAW BAUE LEAGER PECETYE TAKE ANY TO TAKE TAKE TAKE TAKE TAKE TAKE TO BE MEANY TO TAKE TO BE MEANY FOR TAKE.	
	CTC ATRPLANE)		Naug		
	ONS SYSTEM 3	21.5 g	100	\$18C	
	SUBSYSTEM FUNCTIONS	THAN BEING NOT LOWIST			į
- STHRI	SYSTEM 1	S, OTHER TY	AND EM MORPORA WARNING CATE H SIGHTS	(6.) MISTER MODE	ACT CT
WOICENT THE	COMPUTER FUNCTIONS	SELECT / ADVANCE) THESE CHECKUST ITEMS, OTHER THAN REPO FROM THE MPD ARE NOT RELATED AND ARE NOT DETAILED	500dz	WK) EXTERMAL RADIO COMPAT	(4.) EXTERNAL PADIO CONTRCT (4.) EXTERNAL RADIO CONTRCT (1.) INTERCOMM SYSTEM
ENCE DIAGRAM	IAYS	NOW NOW	A	1.TAME OFF ". 1.CMT (V)(E) (M)(E) (H)(E)	(4.) EXTER (4.) EXTER (1.) INTER
IDAMST FUNCTIONAL SEQUENCE DIAGRAM	COCKPIT FUNCTIONS				

SHEET NO. I-B		And the medical and another production and the second seco	8		3	CP MATCHES RIGHT VING PMOTES BLUE 5 & 6 ALSO HOVING CUT. ENTERS TAXI IN TWAIL REMIND M 15 LEADER 51 ENTERS	PACP DURING TAXI MAINTAIN GECUS DISPLAY OF SEE NAMM, MID. HSD, FLIGHTE SYSTEMS PARAMETERS		CLEM BLUE FLIGHT TO TOMER FREG. CHANGE FREGS VIA INK.	Spire sale	150 petrolia gassa:	
	(TO ATRPLANE)	OMORS	CHIEF	AND E	\$	d					STATISMENT	
	RS System 3	мо стако		BONES &	STEER STEER	ACCURATION.	AMOUNT THE					
,	SUBSYSTEM FUNCTIONS SYSTEM 2	\$ (3)		PROPUL. PUR.	3	N. M. O.	THE COL			COLUMN TANK		
1 - TAXI	SYSTEM 1	900000	anceria.	RT. COMT. 3VS.		A 13						
DIAGRAM TITLE MISSION	COMPUTER FUNCTIONS	SYSTEM	NE RADIO CONTRET & SKE .		FLT. CONT. PER.			APPART MOUSE MANDEN	WITH & COMPUT. SALL YOU ON	COCHAIL THRUSTE VILLED	COMPLETE SUBSECTION OF SUBSECT	Fleude
L SEQUENCE	CONTROLS DISPLAYS	I. MERCONN :	- 4. EXTERNA	1	30E	6		Ç			HOPE CONTROL TO	
IDANST FUNCTIONA	CREV CON	⊕ •	2 3		DE 1						STATE OF THE STATE	

EXTERNAL	SYSTEM 3 (TO AIRPLANE) IIME, PRIUKIIY, KETARKS		927d	איזסדי, איזידי, בי שאומשט אפיזד	≜ δ δ	POSMOW NESET PACE	IEVIDEN ON	8 8 2	TOW TOW	TULBAN
SUBSYSTEM FUNCTIONS	SYSTEM 2 SYS	ELECTIOCAL POR			ICS NOT MINE SWITCH ON	Vier 3560k POS	ENGE POST			
	SYSTEM 1	900	ACTUST	MM-KE ON MEE			(A) (E) (E)	(b	E) (E) (E)	CONTINCT)
	COMPUTER FUNCTIONS		COCKET LEATING AUG	PILOT & COPIOT NA	VISUAL POSITION/READ-OUT		100 mm m	(EXTERNAL RADIO CONTACT)	(TAXI)	FRUML RADIO CONTRCT)
COCKPIT FUNCTIONS	DISPLAYS		VOE.	VOC	3	DOG.	309	, (ES	7 V V C	4. (exter

Sheel NO.	TIME, PRIORITY, REMARKS	860	P. PELEASES MAKES AND ADVANCES FORER TO T.O. THENST CP. MINITRONS FIRET	STATE OF THE PARTY	ONLY WAT, W.O. MD POSITIVE MITE OF GLING	· · · · ·		PACP - TOMER CLEANS MLVE 4 TO DEPARTURE CONTINGL. CP ACK.S AND CHANGES FIREQ VIA THE AND NATS. CP - NAKUNE THRUST ANJ.	ភម្ពុខ ខក្	CP - CHECKS AIR COND. AND PRESS. STR PRACE PAREL SPEED PRACE LIMITER SET.	CONFLET. "SELECTS "EMBUTE" 10MST MSTER MORE 0209		JIR. GOODLA SAMER
CVTCDMAL	(TO ATRPLANE)									15	1000	O UTIONWOOD	Skieblin
	SYSTEM 3		numer. Della								The State of		
TING OLI	SUBSYSTEM FUNCTIONS		OVENC UNIT						THE CHIEF		P.E. SIMI	ENGINES	
WW.	SYSTEM 1		- ME DOTO		UT CHECKS		ĥ	2	58.458		AR CONO.C		COULTY.
MORE LINE	COMPUTER FUNCTIONS	(THRI)		COMMUNIC PLIENT PUNCTIONS	WSUAL FOSTION / READ-OUT	ERNAL PADIO CONTACT)	: SELECT (IMK) & NEG. SELE	(PROPUSION POWER ACTUST	(FRS AGUST)	LB	(varied	(A)	BONG UNITER SET MEDIUM
IDATS FUNCTIONAL SEGUENCE DIMONAL	CREW CONTROLS DISPLAYS	8-1-8	ACO ACO	Š A	D 12	CP S	1 (a)	- 12 - 12	F 1-8	"Cum chear	100 P		EHE)

SHEET NO	TIME, PRIORITY, REMARKS		PECP - MONITOR SKE DYST. PLACED BLUE 4 8MM. PLACED BLUE 4 8MM. P. SIGMALS *** COMPAND ON SKE FCI. GIVES CP CLOSINE SPEED CP - GOVERN CP CLOSINE SPEED CP CLOSINE S		5ET = 0, TRACK SET = 0, TRACK SET = 0, TRACK SET 12,000 FT. AND PROX. MARN PROF. MARN PROF. LEAD REPORT "OUT OF 10,000,	OVER SEA 1SLE. OVERS (SKE DVST) CLOSING ON 2 IN SLOT AFT OF BLUE 1. ACTUATES —— ON SKE FCI	CP -GIVES BLUE 5 & 6 MEN SPEED. P -ACTUATES "EXECUTE" FCI	PICP -HEAR DEPARTURE CONT. CLEAR BLUE FIGHT ON COURSE CONTACT N.Y.	CENTER ON 251.4. CP -REDUCES PROPUL. PAR TO MAINTAIN 240KT. CLIME CLIME FEATER	OF 9 CLIMSING THROUGH	1447 14500 v.	ACT NOT THE PERSON OF THE PERS
	(TO AIRPLANE)		THE OF THE FACT F30" SIMPLEY TO SEQUENCE UST THE SAME THE SAME								The state of the s	
	IONS SYSTEM 3		EXMINE OF THE FACT TO SYSTEMS HAVE BEEN ETHE FOOTSMINLEY TO THEK SEQUENCE UST ABOUT THE SAME AS THE THE SAME AS THE THE SAME						Manual Tana			
(8	SUBSYSTEM FUNCTIONS SYSTEM 2		THIS PIECE IS AN EXAMPLE THAT SYSTEMS EXERCISED ONCE THE FREEDOWN THAT THAT THAT THAT THAT THAT THAT THA									
MISSION I - CLIMB	SYSTEM 1	CE CE	THIS PA THAT A ENSERCE ENSERVE THAT C		d				18			
1111E M135/0	NCT10	(E) (E) (E)	· ·	L RADIO CONTRET)	(PROPILSION POWER ACTUST)	(SKE OFERATION)	RADIO CONTRCT)	DPERATION)	RADIO CONTRCT)	KSUON POWER ROTUST)	MIDIO CONTRCT)	FIGURE 116
SEQUENCE DIAGRAM	PLAYS	NO.	(FCI OFFINDA	4. (EXTERNAL	PS I-8 (MOP)	FG 63	4. EXTERNAL	7. (FC! OPE	4. (EXTERNAL	75 I-8 (PROL	4. (EXTERML	
DAPET FUNCTIONAL SI	COCKPIT FUNCTI											
2	CREA	8		8 8 .	200	. 8	\$ 0	\$	3 \$	0 8	0 8	

SMEET NO.	EXTERNAL TIME, PRIORITY, REMARKS (TO AIRPLANE)	Military science of software science over control of the	PACP HEAR N.V. CENTER, "NOGER SQUARK 3426 IDENT." OF IDENT." PACP HEAR N.V. CENTER "N.UE 1 NAMA CONTACT CLIM TO R. 130. SQUARK 240. ART OF R. 200.		CP CAMMES PROG. TO CP CAMMES PROG. TO CP CAMMES PROG. TO TO TO TO TO TO TO TO TO TO	PACE - NEAR ANNOUNCE TOWER PRINCE TALLING PRINCET GLAND AT THIS TIME. MAINTAIN 13 PILYMAY, G. SECONDAY. PECRT 3000 MITH YORK	2315 -PACP NOTE FORWATION 11 POSITION AND FLIGHT	Transmittee of the fire	NEW STREET, ST	
	SYSTEM 3		CLIMB PERSOD THE CIP ON THE MANIFOLDS CLIP OF THE MANIFOLD CONTROL OF THE MANIFOLD CONTROL OF THE MENTAL OF THE ME	T ROSEINLY FOR (ANY -LOT) SYSTEM E SES ENT ON A ROCHANCE SHOULD OR BETTER THAN SYSTEM. A DETHINA Y RECOMMENDED.						STATE OF THE PERSON NAMED IN COLUMN NAMED IN C
	SUBSYSTEM FUNCTIONS EM 1 SYSTEM 2		DANK THE CLIPS IN THE MAY AND ESTIMATION OF CORPULTY BY CROSS OTHER ANCHORY IN	DEPRENTED OPS ACCUMATION THE COMPLEX SKE (BUTH ALL AIRCRAFT & DOWNON GRID PERPORT THE PRESENT THE PRESENT THE SKE (STUDY IS STREAMENT					The selfer I	THE REAL PROPERTY AND ADDRESS OF THE PARTY AND
	COMPUTER FUNCTIONS SYSTEM	WAL RADIO CONTRCTS)	OPERATION)		Legister approcessor and ages.	A SECTION CONTRACT.	(Separa consuming states and	SHE CHERNICAL	COMPOSED SOUTH COMP	からからいないないのであれていていて、日本
	CREM CONTROLS DISPLAYS	ACO A	¥ '' '' 'E' E' E				S	4 A 10/02 E.S.	Series Cardia	CHARLE STREET, CORP. A CHARLE OF LAND

	TIME, PRIORITY, REMARKS		9	FECT - HONITORING FORMATION STATUS ON SEE DIST STATUS ON SEE DIST CONTINUE, PACE CP - READJUSTS RADAR (TH BOTH HOOS) AT MAX. RANGE, LOOKS	FOR TANKER IDENT. SIGNAL. CP ATTEMPTS UNF CONTACT MITH DESIGNATED TANKER (ESSO 67) REQUESTS AIR CP SEFETN AND REPUBLING SEFETN AND REPU		PACP -HEAR TANKER LEAD REQUESTED TO CONTINUE PRESENT COURSE.	CP STARTS AIR REFUEL CHECKLIST 06.46 PACP RECEIVE DESCRIT COMMAND ON FCI	CP - EXECUTE SIGNAL-FCI. ADJUSTS POMER FOR CRUISE DESCENT	PACP - HONITORING SKE AND RADAR DISPLAYS - CP REPORTS TANKERS 12	=	CP - ATR REFUEL CHECKLIST COMPLETED* PACP - RECEIVE "LEVEL OFF ON EXECUTE SIGNAL."		
FYTERMAI	(TO AIRPLANE)						Table State		cows					
OMC	SYSTEM 3								THINER BO	STANCE				
CHRCYCTEM EHNETTONS	SYSTEM 2								RECOGNIZES THINER BEACONS	DEMONS & DISTANCE				
Ū	SYSTEM 1		SYSTEM)		, Tan	vstem)	No.	•	instem)	TAWKER				
CLIRCYCTEM FINCT	COMPUTER FUNCTIONS	(SKE OPERATION)	(RADAR CONTROL SUBSYSTEM)	WAL RADIO COMMET)	ER MODE SELECT) "AIR REFUEL"	(RADAR CONTROL SUBSYSTEM)	(FCI OPERATION)	(PROPUSION POWER ROJUST)	O (RADAR CONTROL SUBSYSTEM)	(INTERCORM SYS) REPORTING	(EXTERNAL RADIO CONTACT)		OWALE SHELSING	Fidure 118
COCKDIT SIMILTIONS	CREW CONTROLS DISPLAYS	TO V F/6. 83	# 780"	**************************************		76. 780	7	© 2.1.9 (€)	P (FG. 780	7 1 1 1 2	**************************************	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		The same of the sa

	PACE VECTIVE ERECUTE STEMA, FOR LEVEL OFF. (27,000 FT.) - FOUNTINES BY VISHA, AND SAF PEARS.	MO HEN BLE LEGER REPORTS '12 0'GLECK - O HENGES '12 0'GLECK -	OTAL TOR SO, 46, 40, 86, 30, 30, 30, 30, 30, 30, 30, 30, 30, 30	MITH TAMES VISHAL CONTACT MITH TAMES POWNTION. MICH SANSES PLOT. PACP - NOTES VISHALLY ESSO 11 3 MILES OUT ON	P MARALEL THACK. P MEDUESTS ESSO SLOW TO 289 KTS. CP THESTRACTS BLUE S & 6 TO MOVE TO MEDUEL. TO MOVE TO MEDUEL.	P. CALLS FOR "PREPARE FOR CONTACT CAECILIST." DACP CAECIL: AIR COMO. SYS. CMC.		
DICE								
ISUAL REFER				2		((3) T		
DITERMAL		STANCE					(سعند	200 000
OPERATION) (SHE OPERATION)	EXERMIL MOIO CONTICT)	THE THURE BOTEINS & D	EXTERMAL MOIO COMPAT)	EXTERNAL VISUAL REPUBLIC	MRE FOR COMPAT CHECKL	CONO	io (mone commor sues	FIGURE 119
7. FIG. 63	* -	- 8	*	,A,	1	200	8. E	
			- DAC		IE			NOT TO SELECT
	FIG. 03 (SHE CHERTON) - ENTERNAL WISHAL REFER	FIG. 03 (SINE CIPERTION) - BITEBURL VISUAL REFERENCE 4. (EXTERNAL PRICE CONTRCT) 1. (INTERCOMM 378.)	FIG. 03 (Sine creation) - extremit, Visual nevertions (a) +, (extremit those connect) (b) - 1. (innercoun 318.) (c) - 1. (innercoun 318.) (d) - 1. (innercoun 318.)	The contraction of the contracti	TO (PC) OPERATION) - BOTTERNAL WISUAL REFERENCE (A) (ENTERNAL RICCO CONTINCT) (B) (ENTERNAL RICCO CONTINCT) (C) (ENTERNAL RICCO CONTINCT) (ENTERNAL RICCO CONTINCT) (ENTERNAL RICCO CONTINCT) (ENTERNAL RICCO CONTINCT)	(a) Fig. 03 (Sing demonstrate) - Extreme Visual Reversionice (b) 4. (Extreme Ring of Dather) (c) (Antercount Sts.) (d) (Antercount Sts.) (e) (Extreme Ring of Dather) (e) (Extreme Ring of Dather) (e) (Extreme Ring of Dather) (f) (Extreme Ring of Dather) (g)	(a) Fig. 63 (Sing Contract) (b) Fig. 63 (Sing Contract) (c) Fig. 63 (Sing Contract) (d) Fig. 63 (Sing Contract) (e) Fig. 64 (Sing Contract) (e) Fig. 64 (Sing Contract) (e) Fig. 64 (Sing Contract) (f) Fig. 64 (Fig. 64) (g) Fig. 64 (Sing Contract) (g) Fig. 65 (Sing Cont	(A) FIG. 03 (Size creamon) + extreme Visual Reference (A) H. (Extreme Proc Councy) (B) H. (Intercount 97s.) (B) H. (Intercount 97s.) (C) H. (Intercount 97s.) (E) H. (Inter

TIME, PRIORITY, REMARKS		PACP CHECK (CONT.) **NO SHOKE -**MITOPILOT DISBIGACE -**SLIPMAY TOOR-OPEN -**REDUCE POMER TO \$1.0M -**REDUCE POMER TO \$1.0M -**TO \$775 KTS. (INCLUDING	FCI STEMULS TO BLUE 5 & 6) -ANTICOLLISTON LTOFF -NAV LIGHTS-OFF -NAV LIGHTS-OFF -NAV LIGHTS-OFF -NAV LIGHTS-OFF -NAV STITCH-ON -STIGNAL ANP -NESET -STIGNAL AND -NES	PUCP - ENTER REFUEL ENVELOPE - HOLDS ENVELOPE DOSSIT. ATOR SEATS BOON OVER. ATOR SEATS BOON NOZLE IN RECEPTACLE CONTES AND REPORTS - CONTACT", "FUEL FLOW". NOTES FLOW PATE 1S 6000 LBS, MINI. CHANGES FLOW PATH TO SOURD. TAMEL MATCHES CONT	P. TANICR PLOT AND BOOM OFFICE AND BOOM OFFICE PLOT AND BOOM OFFICE PLOT AND BOOM OFFICE PLOT AND AMEES C.	PRINCES POMER DANGES BACK OUT OF REVEL BIVELOPE.
1 1		િ			EE (C) BECONNECT	
SUBSYSTEM FUNCTIONS EXTERNA	TO PRES/CARGO AR	THEMS ARE SIMILAR TO ABOVE & TO (MOPULSION PUR. AUTUST) L. RADIO COMMET) ERATION)	TS FOR AIR REPUBLING THIL IN THIS NOTE. REFUEL SYSTEM STATUS			
COMPUTER FUNCTIONS	"NO STORE"	F 20	THE PLIGHT REQUIREMENTS FOR AIR REPRINCES OF CONTRACT OF THE PROPERTY OF STEPHENTS OF THE PROPERTY OF T	(EXTERNAL RADIO CONTRCT)	JUE MASONIN. MENT PS. I-B (PROPULSION POWER MODULET)	(FLUNT MMEUVERS)
COCKPIT FUNCTIONS	1000 F	INDER OF CH		*	PLE V V V V V V V V V V V V V V V V V V V	△

SMEEL NO. 1-16	TIME, PRIORITY, REMARKS	CLEMS TAMKER AND HOVES TO LEFT OF TAMKER AND HOVES TO LEFT OF TAMKER AND OWNE IN FOR METHEL. MOYELIN FOR "MOST AIR METHELY SPECIPOMAKE CALLS FOR "MOST AIR METHELY SPECIF SPE	CP - COPPLETS BLUE 4 ELDERIT FUEL LOG MEN BLUE 5 6 6 MEN BLUE 5 6 6 MEN BLUE 5 0 0 MEN AZORES PACP - INITIATE CLING TO 07-40 FL 370 WITH FORWATION.
EYTEDHAI	(TO AIRPLANE)		
OW.	SYSTEM 3		,
CHREVETEM EINCTIONS	SYSTEM 2	SO TO	T
	SYSTEM 1	ARCONFT ELECT. PUR (TE) (T) (E) (E) ROWDOW SENSOR SENSOR	t (V) rue
	COMPUTER FUNCTIONS	TERMIL R	(EXTERNAL KADIO CONTRCT) (EXTERNAL RADIO CONTRCT) [-8 (PROPALSION POWER ADDUST) & [>> FUEAT MANEUVERS
COCKPIT FINCTIONS	CREM CONTROLS DISPLAYS		

SHEET NO. I-17	L TIME PRIORITY BEMARKS			0312 CP -NOTES 20 MIN. FROM	CARP ON MAP AND MAY. STATUS DISPLAY (HSD AND MPD) CP -ALERTS PALM. P CP IM -START 20 MTM PMERY	P ACTUATES "AIR DROP" MASTER MODO. PROP. PERVIEW AND CAECK AIR DROP PROCEDURES AND	DATA ON MPD. SLONDON PROCEDURE DROP POINT AIR SPEED AND ALT. DEPARTURE PROC.	***	SKE FOL SEACHT ON SKE FOL SEC SENT ON EXECUTE SIGNAL FOL.	P - REDUCES FOMEN AND STARTS SLOW DESCENT (-670FPM) CP - CONTIACT HAMOVER RADIO. CP - RECEIVES REQUEST TO	CP CONTACTS "LORE SAIP" CP CONTACTS "LONE SAIP" CP R RADAR ADVISORIES.		0320 PECELVE LONE SHIP RADAR ADVISORIES RE' ENERY AND OMN AIRCRAFT.	State of Care Service	COREST NO.
	EXTERNAL	(TO AIRPLANE)		-(24) 4											
H.E. AIRDROP	100000	SYSTEM 3													
ALTITUDE H.	SUBSYSTEM FUNCTIONS	SYSTEM 2	FUNCTIONS				-			 	T#0#-				
- HIGH 4		SYSTEM 1	FUSHT							BLEED ELECT.		SENSOR			
AGRAM TITLE MISSION I	COMPLITED FINCTIONS	CONTOIEN FONCTIONS	CONTINUAL		com 515.)	(MASTER MODE SELECT)	(INTERCOMM SYS.)	(FC! OPERATION)	PG. I-8 (PROPULSION POWER ADJUST)	4. (EXTERNAL RADIO CONTACTS)	(B.) MM1-1CE \$ DE-1CE		ENAL RADIO CONTACT)	checkate who case	FIGURE 122
IDANST FUNCTIONAL SEQUENCE DIAGRAM		CONTROLS DISPLAYS		V +130, nPD	A (IMERCONN	(MASTE	A (INTERC	7 (36)	FG. F- 8 (P				S . (EXTERNAL		A LANCOUS OF SEED OF
IDA		8	40 to	8	9 8	. 2	8 8	a &	a \$	3 8	4		6 \$		

SHEET NO. I- IB	TIME, PRIORITY, REMARKS	CONTROLLES TO WIN. FROM CAP ON IDNEST WA. ALERTS PALM. P.CP.LM START TO WIN. CHECKS OF CHECKS WAY SYSTEM THAN POINT AND SENDS "EXECUTE" ON FLI. P.STARTS THAN TO ONSO. P.STARTS THAN TH	2005 6 119129 3013
11	CTO ATRPLANE))
. AIROROP	SYSTEM 3		mom and
I - HIGH ALTITUDE - H.E. AIRDROP	SYSTEM 2	KE NOUNE	(wwo days for mine, they wrong
- HIGH W	SYSTEM 1	If b	ed amm)
MOISSILM THE MISSION	COMPUTER FUNCTIONS	CHECKLISTS) IR CONOMING SYS IR CONOMIN	MAN SYSTEM UPDATE
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IDAMST	8	CREW	⊕ £	S Co		企它	147			0				

FINCTIONS EXTERNAL	SYSTEM 3 (TO AIRPLANE) TIME, PRIORITY, REMARKS	1046:30 P. THREASES POWER ON GOOD ENGINE. CALLS FOR FLAPS UP. CP. PROVES FLAPS UP. UP POSITION PACP - NOTE: - #1 ENG. FIRE L.	P CLIMBING TO 1000 FT. P - CLIMBING TO 1000 FT. NSL. CP - STARTS ON FIRE AND FUEL	P - CALLS PULL FIRE MANDLE CP - PULLS HANDLE AND RFTS CP - CALLS FREEEAS BOTTLE ON	P - MOVES PP - MOVES P	IN TERPORTS FIRE LIGHT. AND LOCKED AND STARTING AND LOCKED AND STARTING PAYLOND CHECK. CP NOTES AND REPORTS FIRE LIGHT OUT. P TERPORTS FIRE THE TOTAL START TO THE	. 6		TOTAL S. L.		
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3	CREW CONTROLS DISPLAYS	TVV T	

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ns	SYSTEM 1	T PLAN () CHILUP & MEVIEW CHIRE MAY 37578 CHIRE SYS.) FINDER SYS.) The I-3 The
18	CONFUIER FUNCTIONS	ECT IME, NET-3 RIDIO CONTRCT, (AUTO. DIEECT. (SKE OFFICHING. FIGURE 133
COCKPIT FUNCTIONS	CREM CONTROLS DISPLAYS	

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TIME DOINDITY DEMANY	IIME, PRIURIII, REPHANS	•		STARTS RIGHT TURN TO ROLL OUT ON "LOC". PATH - REDUCES POWER TO SLOW DOWN TO APPROACH	SPEED. STARTS DESCENT. PACP - CLEARED TO CONTACT EHAM APPROACH CONTROL. P -*LAND* MASTER NODE	0	MIND AND NX.	00 100 100 100 100 000 000 000 000 000	1059 CP STARTS "LAND" CHECKLIST. CP -10 MILES, APPROACHING GATE (9MI. GATE) AT	P. COMPLETES CHECKLIST. P. "9 MILE GATE, 3500 FT." P. "8 MILES, 3100 FT." FOLLOWING "LOC AND 6S" (ASA)			=	
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COCKPIT FUNCTI	CREW CONTROLS DISPLAYS	CP (T) FIG. 63	PACE A 1. (WERCOMM	CP (S) 4. (EXTERMIL	776	P	CP S) # (EXTEN	D THE STEE		CP STERNAL W. (EXTERNAL		1)	

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DIO CONTACT, 15.	RAD.	OPERATION, 15 III-3)	FIGURE 135
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SECTION VII

SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The foregoing Subsystem Sequence Diagrams together with the Level 1 and 2 Functional Sequence Diagrams, comprise all of the Operational Sequence Diagrams (OSD's) developed for the C-14 IDAMST program. These OSD's have identified categories of software subroutines which are required to interface AMST avionic hardware systems with crew functions in operational environments. This data has been referenced by Software Engineering personnel in support of their IDAMST software specification development task. Those specifications are included in the IDAMST software specifications, SB 4041 through SB 4044.

Each element of the OSD mission analysis contains concepts which will formulate the general character of the IDAMST system. But some of those concepts are controversial in the sense that they do not have universal acceptance on the part of the Air Force and Contractor technical personnel currently planning advanced tactical air delivery systems. A number of contradictory factors confound their approaches to a rational solution. These factors are summarized in the following outline:

- . It is universally recognized that a modern replacement is needed for the C-130 in the early 1980's.
- . Ideally that replacement should have high performance STOL capabilities, but be relatively low in cost based on a reasonable production run.
- . To suppress the growing impact of personnel cost on overall program expenditures, the AMST crew size must be held to minimum.
- . To perform the most demanding air drop missions with a two-man crew, the AMST avionics system will have to be automated and integrated, and will probably have to contain more sophisticated components than the current system.
- . The Life Cycle cost of the advanced avionics should be significantly less than the funding required for current technology systems operated by larger crew complements.

Personnel conducting the IDAMST mission analysis have been mindful of these factors as they performed work elements during the study. Wherever possible they have sought to incorporate concepts which tend to alleviate rather than aggravate these considerations. By that, it is meant that the technical approach has emphasized software enhancement of existing systems which can be automated and integrated; this in lieu of specifying advanced technology systems which carry with them unacceptable costs.

The following paragraphs summarize the conclusions which have evolved from the mission analysis performed in light of the factors noted above.

7.2 CONCLUSIONS

The most severe requirement for the AMST is the precision air drop under Instrument Meteorological Conditions (IMC) with a two-man flight crew. With respect to avionics systems, the possible solutions to the requirement may be accomplished in several steps, each involving progressive technology levels of indenture.

7.2.1 Initial IDAMST System

To facilitate two-man flight crew control of the AMST, it is obvious that all navigation functions need to be automated so that they require a minimum of operator interaction. Coincident with that task, the basic components (INS and Omega) need to be functionally integrated with complementary systems which can amplify positional information. These complementary systems include radio aids, Drop Zone Marker, Search/Weather radar, station keeping equipment, compasses, and altimeters. Data from these systems, when integrated with basic system data significantly enhance geographic and tactical navigation.

NOTE: The performance of the proposed AMST radar is not going to provide exceptionally good terrain mapping information.

Consequently, its contribution to navigation tasks is not expected to be great.

To enhance survivability in hostile environments, it may be desirable to integrate passive ECM data into navigation outputs to assist the crew in rapidly fixing the relative bearings of potential threats.

The use of the computer to automate communications tasks will make flight deck tasks less complex. The most immediate objective is to provide for pretuning of the separate radios so that selection is by channel rather than frequency.

In the area of system monitoring and management, the software subroutines can be used to directly input sensed data to check lists and calculations. The sensed data would include both qualitative and quantitative information related to subsystem status and operation. Records such as weight and balance reports could be updated on a real time basis providing accurate data to the crew at a moment's notice. Likewise, the on-off and moding of subsystems would be available for automatic accounting in check list execution.

Manual check lists demand an inordinate amount of crew time and attention in the current system. Many of those check lists can be automated to the extent that they perform, as well as display, the sequencial items. Where input data is required, the check list subroutine can alternatively call sensed data where it is available, or cue for operator interactive inputs.

Flight procedures may be handled in much the same way as check lists with the exception that they are not likely to be interactive. For instance, the system generated display of Standard Instrument Procedures (SID's), Standard Terminal Area Requirements (STAR's), Missed Approach plates, etc., may be cued as a function of sensed aircraft position and flight mode. The automatic calling of SID's and STAR's could be expanded to include software tuning of communications equipment to the prescribed air traffic control frequencies.

Most of the features which have been identified to enhance AMST mission performance have been solely concerned with improving flight deck tasks but some of these same features can be used to refine cargo compartment functions. Employment of automated check lists is a case in point. This suggests the possibility of providing the Load/Jumpmaster with an abbreviated IMK/MPD panel for operator interaction and that facility provides the means by which Mission/System Visibility can be expanded to refine and expedite cargo compartment management. Closed circuit TV coverage of that area from the flight deck can be used to facilitate remote control of aircraft systems, and the extraction of cargo. That kind of visual coverage supports safety and emergency functions.

7.2.2 Growth IDAMST System

Elements of the basic IDAMST system are described above. Performance of the system could be significantly improved with the incorporation of an advanced Mapping/Terrain Avoidance (M/TA) radar; and alternatively the Joint Tactical Information Distribution System (JTIDS), or the Global Positioning System (GPS). It is presumed that one or the other of JTIDS and GPS will ultimately be incorporated in the AMST.

M/TA Radar

The M/TA radar together with the integrated navigation system makes the AMST a truly all weather system. The INS with Omega supported by the various navigation aids provides worldwide means of transiting to tactical areas. M/TA radar operations together with the navigation subsystems provide the basis for continual position fixing and CARP updating during penetration into the drop area. While zone marker support will still be needed for some operations, the M/TA radar eliminates the absolute reliance on that system for IMC drops.

JTIDS

Figure 136 summarizes all of the operational features that are being planned for the JTIDS system. As the figure indicates, the system is basically a real time tactical command and control system providing the user aircraft with a large volume of information. Threat data in addition to own force information is included. Coincident with that data, the system also provides the receiving aircraft with the means of determining its relative position along with the positions of other units in the tactical area. Regional information on weather and the status of facilities at recovery bases is included. Because of JTIDS system design characteristics, all of the transmitted messages are immune from jamming or unintentional interference. As a consequence, the system is highly reliable and meets all of the requirements of the AMST for tactical data.

GPS

While JTIDS provides relative navigation (with respect to transmitting stations), the GPS enables very accurate geographic navigation for worldwide applications. In most instances, this system in the IDAMST system would become the prime source of positional information with the INS and Omega furnishing backup data.

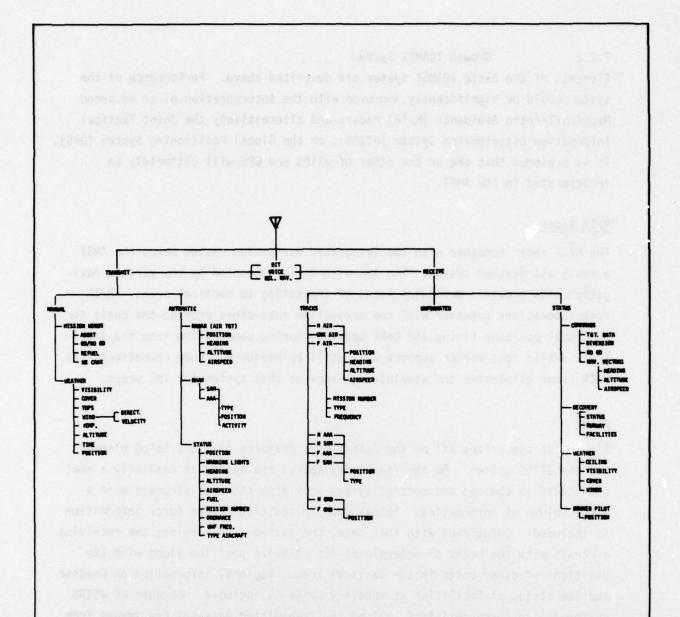


FIGURE NO. 136 Baseline JTIDS Transmit/Receive Functions

7.2.3 General Comments Derived from Time Line and Operational Sequence Diagram Analysis

- The IDAMST concept provides an excellent means of improving the present cumbersome (and too often inaccurate) "See and Feel" circuit breaker status system. An MPD display of circuit breaker status based on reliable CB sensors is an excellent candidate for workload reduction and flight safety improvement.
- O A time-indexed voice recorder with in-flight playback capability appears to be a useful aid in 2-man flight deck operations.
- The complex engine start sequences which still include a requirement for fast pilot reactions to rapid changes in engine parameters should be the subject of a study leading to an automatic start program for the IDAMST.
- o The near future availability of GPS hardware and its expected precision makes this equipment the basis for a possible replacement of the present, complex, SKE system (APN-169). With all aircraft and GPS zone markers on a common grid, station keeping performance using GPS should be equivalent to or better than the present SKE system.
- The detailed manual activity required to establish and execute an airborne radar or station keeping approach makes it almost mandatory that, beyond several manual inputs, the IDAMST concept be able to present complete approach diagrams which include aircraft position. In addition, steering signals should be available for manual/automatic operation.
- O During the analysis it was noted that under some circumstances reliance on the HUD as the primary source of flight information could be dangerous. As an example, consider a C-14 formation employing SKE. If any two aircraft penetrate the same time slot, and a proximity warning is sounded, the pilots must transfer their attention from HUD's to SKE PPI's prior to taking evasive action. It is possible that a collision could occur before the proper break left or right, or climb/dive decision is made. The proper solution to the problem, of course, is to further integrate the system to provide evasive steering commands to the HUD.

7.2.4 IDAMST Benefits to C-14

The exercise of the IDAMST mission analysis tasks leads to several overall conclusions:

First - An automated/integrated system built around IDAMST concepts promises to decrease C-14 flight crew workloads to enhance efficient performance of all AMST missions, and flight safety.

Second - The character of the IDAMST system provides a compatible building block for C-14 application to special missions. Examples are:

. EMI/ELINT

- . Delivery of Sensors and Ordnance
- . RPV Launch/Recovery
- Gunship